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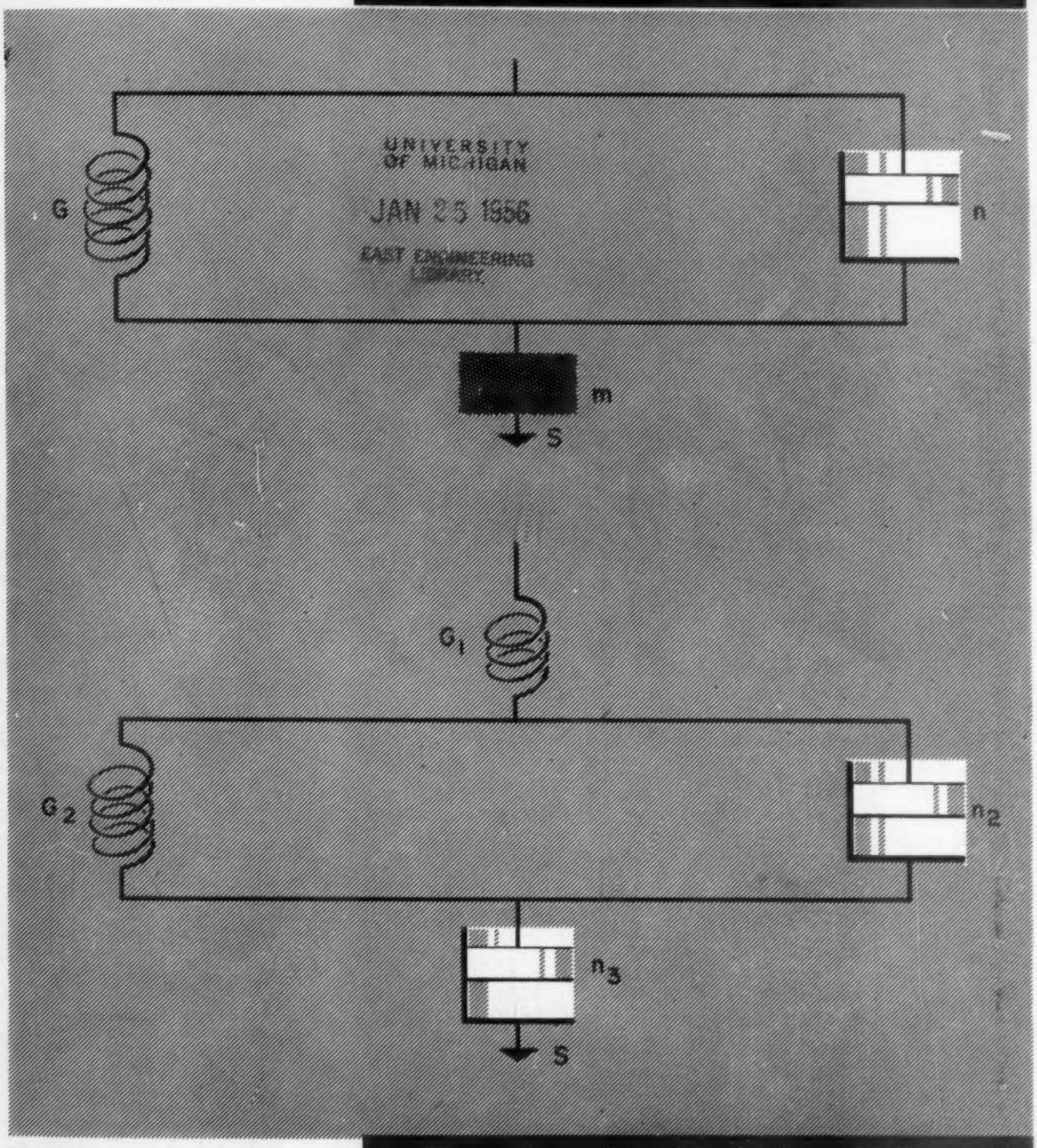
PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING



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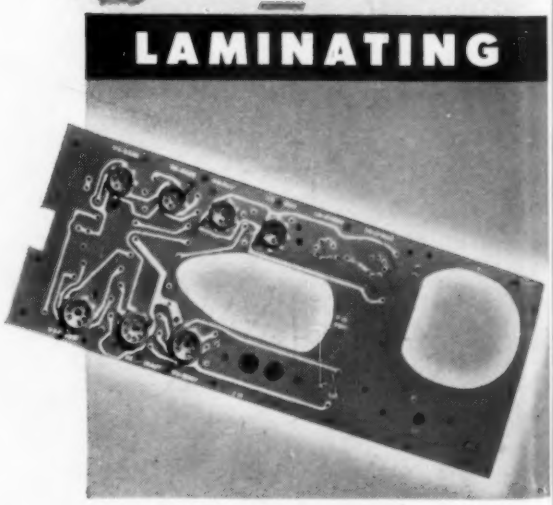

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Letters to the Editor

Polymethylene Advocated

Dear Sir:

Re your editorial in the November issue, we have been advocating "polymethylenes" for the various linear polymers of ethylene made by Ziegler and Phillips techniques. We are interested to note that Plax has come up with the same suggestion.

Roger Williams, Jr., President
Roger Williams Technical & Economic Services, Inc.
New York, New York

• • •

Making Lithium Ricinoleate

Dear Sir:

The November issue carried Part 1 of an article on stabilizers for vinyl chloride and its copolymers. On page 613, the statement was made: "Lithium ricinoleate is not available commercially at this time."

We would like to advise you of the fact that The Baker Castor Oil Company is currently manufacturing lithium ricinoleate in commercial quantities.

J. F. O'Brien
The Baker Castor Oil Co.
New York, New York

• • •

Material Standards Needed

Dear Sir:

Your editorial, "The Coming Confusion in Polyethylene," in the November isue is the first such article the writer has seen on a subject that long has been, to say the least, an aggravating problem to molders and, consequently, to the consumer.

Polyethylene, up until now, is one material that has enjoyed wide consumer acceptance, and we certainly agree that publicizing the virtues of the Ziegler-type polyethylene under the mere classification of "polyethylene" or "low-pressure polyethylene" will certainly raise havoc with an already-established multitude of very acceptable products produced from the high-pressure polyethylenes.

This situation does not prevail only in the polyethylene family, however. The styrene family has a wide range of regular, medium, and high-impact varieties, and the nylon family, too, is beginning to develop. To have so many variations of basic materials is naturally beneficial to the molders if all molders think alike in judging the best suited material for a given application.

Many material specifications on customers' drawings merely state "nylon" or "styrene" or "high-impact styrene." If the molder has a choice within the basic material category, it is quite easy to see the problem if there is a price differential.

This all leads to the great need for a standard classification of materials in the plastics industry. The first thing we need is a clear-cut, unified way of presenting physical data on materials to the processor. This might include the development of new test methods specifically designed to give a more true comparison of plastic materials.

Secondly, we need a "Plastic Material Standard" which, by a simple number group, would designate a particular grade or type of basic material; such as PMS-1247, where 1 is the basic material group, 2 is the modification (if any), 4 is the flow or melt index, and 7 is the heat degradation temperature of the material. A molder then could purchase a particular material from any supplier and, once having evaluated a particular PMS type, he would have tangible knowledge of the material for future applications.

As it goes, the plastic materials industry is becoming more and more confusing to the molders and to the product designers as well. It is time for the industry to at least initiate some form of material standardization.

Richard A. Rybak, Chief Engineer
The R & K Tool & Die Co.,
Cleveland, Ohio

(We agree wholeheartedly on the need for proper material specification standards. The SPI has made a start in this direction in their "Plastics Engineering Handbook" with a compilation of coded specifications for rigid plastic materials. We would be interested in hearing from our readers on the subject of material standards.—Editor)

• • •

Our Slip is Showing

Dear Sir:

Although the fact that Monsanto will increase production capacity of ethylene by 150% was correctly reported on page 639 of your November issue, it was misinterpreted in the lead paragraph of your "News in Brief" section on page 605. In other words, we are talking about ethylene rather than polyethylene.

C. Judd Holt, Jr., Public Relations
Monsanto Chemical Co., Plastics Div.
Springfield, Mass.

(Our sincere apologies for the error. We must have polyethylene on the brain to have made the typo mistake.—Editor)

• • •

Likes Price Listings

Dear Sir:

Recent issues of PLASTICS TECHNOLOGY have contained much more complete listings of current market prices on raw materials than early issues. We find this very valuable as a ready reference from both the sales and formulation viewpoints.

Because we are manufacturers of vinyl plasticizers, we are very interested in this particular section, and would like to have our Admex plasticizers listed also. Our Admex 710, 711, and 744 are rapidly becoming the standards of the industry, and are used by all segments of the vinyl processing field.

I am enclosing a current price list on these products, and will keep you advised on any future price changes.

R. S. Mathews, Manager
Vinyl Plasticizers
Archer-Daniels-Midland Co.
Minneapolis, Minn.

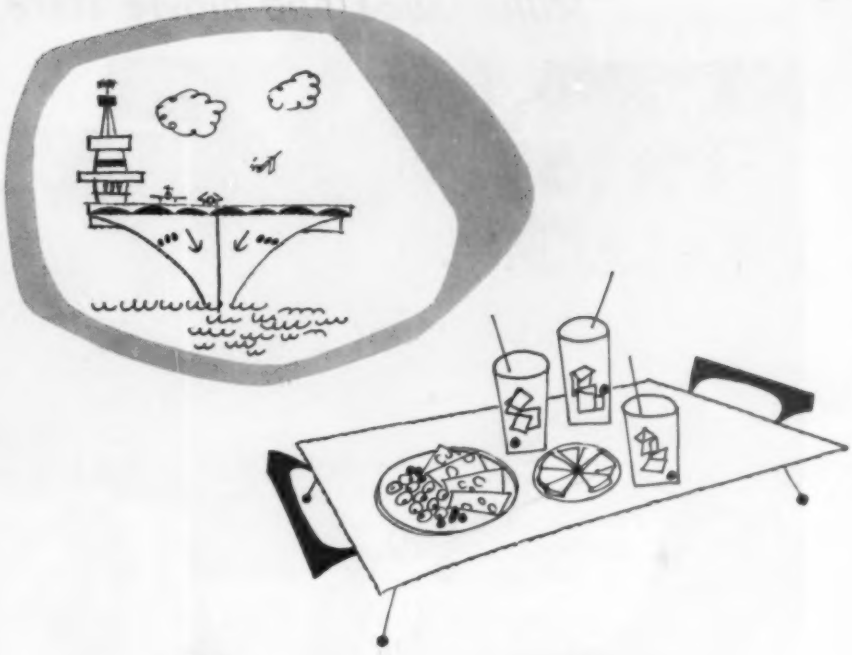
(This letter is being printed to remind manufacturing firms that we would like to include their materials in our listing of Current Market Prices.—Editor).

• • •

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation, and address.

Letters requesting information on technical or engineering problems will be printed to elicit replies by the readers, either directly or through these columns. Upon request the identities of such "problem" letters will not be divulged.

—The Editor



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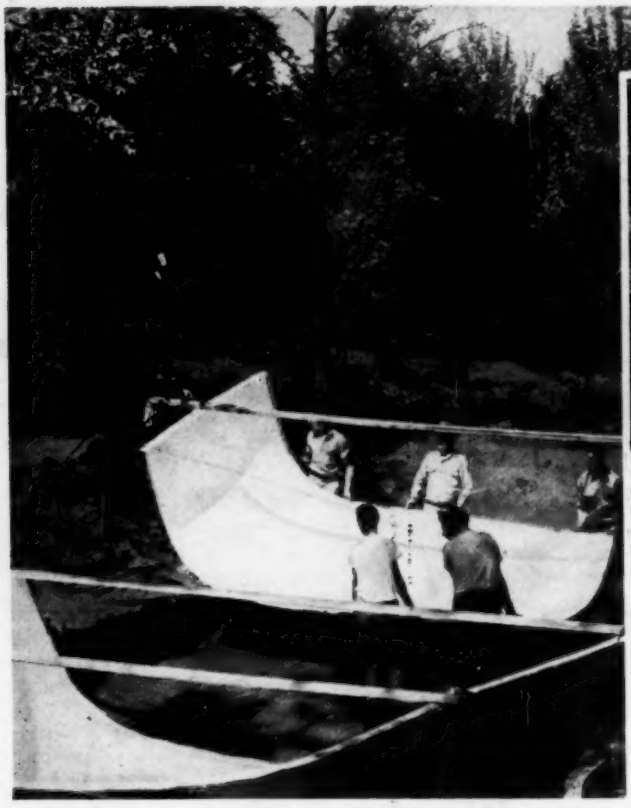

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NEWS in BRIEF

Plastics raw material production in 1955 reached a new high of about 3.6-billion pounds, the SPI estimates (see page 39). This total is an increase of 30% over the 1954 figure. Plastics raw material production in 1956 is expected to reach a new record of 4-billion pounds. The industry's growth since World War II has increased its production volume by more than 400%. Production increases in 1955 over the preceding year were: phenolic molding materials, about 16%; cellulosic molding materials, about 21%; vinyl molding materials, about 26%; polystyrene molding materials, about 30%; and polyethylene, about 50%. The value of plastics products at the consumer level amounted to $1.8-billion in 1955, as compared with $1.4-billion in 1954.

Chemical industry sales for 1955 will reach a new record of about $23-billion, MCA estimates, a figure 17.6% higher than the 1954 level. Total investment in plant expansions for 1955 is expected to exceed $1-billion for the fifth consecutive year. Chemical production in 1955 also set a new high.

Packaging field promises to be one of the most important areas for vinyl application, says Roger S. Firestone, president of Firestone Plastics Co. (see guest editorial, page 24). Greatest impetus for use of vinyls in this field came from the elimination of the taste, odor, and toxicity problems previously encountered with this plastic. Improvements in production of vinyl films and coatings have helped the packaging industry find more applications that utilize the versatility of these materials.

Financial changes in the plastics industry included the purchase of American Resinous Chemicals and Reslac Chemicals by Borden; negotiations by American Cyanamid to buy Formica Corp.; the purchase of Watson-Stillman's press division by Farrel-Birmingham; and the sale to Koppers of controlling interest in Durethene Corp.

Flood of company expansions in plastics continues unchecked. An extensive expansion program has been completed by American Molding Powder & Chemical to manufacture concentrated pigment dispersions and a full line of colorants for thermoplastics. Canadian Industries is setting up a temporary polyethylene technical service lab at its York paint plant. Dow will build two new plants for styrene foam. Du Pont will erect the first full-scale plant for chlorosul-fonated polyethylene rubber in Texas, and plans to increase output of titanium dioxide pigments at its Edge Moor, Del., and Baltimore, Md., plants. Koppers and Brea Chemicals will join in the construction and operation of a new plant for Ziegler-type polyethylene on the West Coast. Loma Plastics had added more office and warehouse space, as another step in its $750,000 expansion program. The new plant of Perry Plastics in Erie, Pa., is set for occupation this month. Prodex Corp. is moving to a new plant in Fords, N. J. Reichhold is buying a new site in Tacoma, Wash., for a dry adhesives plant and warehouse.

New Materials of interest (see page 47): new polyester resin for producing transparent fibrous glass-reinforced laminates; two general-purpose wood flour-filled phenolics; six organo-silicone release agents; and epoxy-type stabilizing plasticizer; a machineable chlorinated polymer; and an alkyd resin for making enamels with improved color and gloss retention.

New Equipment worthy of mention (see page 49): high-speed rotary tabletter; circulator for injection mold temperature maintenance; toggle action semi-automatic press; large injection molding machine; combination vacuum and drape sheet forming machine; and diaphragm control valves.

New Products to be noted (see page 51): disposable laminated package for reasearch-grade chemicals; portable plastic speedometer for boats; lightweight molded melamine valves for airplanes; molded ring lifebuoy of vinyl foam; plastic sandwich panels with expanded styrene cores and glass cloth-reinforced polyester facings; acrylic emulsion binder for coatings; one-piece louvered acrylic windows; polyethylene hand pump; vinyl runner matting; welding torch with fluorocarbon plastic adapter; vinyl sleeving; reinforced plastic skylight; plastic-hulled model boat; and molded fluorocarbon elbows and bellows.

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PLASTICS TECHNOLOGY

JANUARY, 1956

EDITORIAL: Preventing Confusion in Polyethylenes—I

Our November editorial on "The Coming Confusion in Polyethylenes" called attention, in general terms, to the confusion and problems that will beset both the processors and consumers when conventional polyethylenes are joined by the new low-pressure types.

Actually, the problem is quite complex, and a solution will require cooperative efforts by the materials suppliers in educating the polyethylene processors and consumers.

•

Examining the problem in detail, we find that the following four polyethylene types will be on the market in the near future:

(1) Conventional or high-pressure types.
(2) Low-pressure Ziegler-type materials.
(3) Low-pressure Phillips-type materials.
(4) Copolymers of high- and low-pressure types.

Obviously, what is needed by the processors is comprehensive and unbiased information and data on each of the four types. This must include complete physical and chemical property data on each type, and detailed information on how each type should be processed.

This processors' education program should emphasize differences in properties and processing between the types of polyethylene. Unfortunately, this is easier said than done, since a supplier of a new plastic material usually promotes only the features he considers desirable and ignores the others. This only confuses, and tends to strengthen the mistaken implication that the new material replaces the older type, instead of supplementing it in application. Naturally, this was not the supplier's intention, and he then spends time and effort to correct this erroneous impression.

Even the enlightened supplier of a new material sometimes is reluctant to point up differences in properties from the older material when he does not make the latter. This attitude may be commendable, but the net result to the audience is still confusion. Each individual in the audience must make his own comparisons, but all too often these comparisons cannot be made because of incomplete data or properties reported on the bases of non-equivalent test procedures.

•

It is apparent that what is needed is a cooperative program by all the suppliers involved in the four types of polyethylenes to educate the plastics processors and, to a much less-detailed extent, the consumers. This education program should provide the factual data that will permit proper application and use of each of the four types.

Even with such a cooperative program, we need nomenclature differences for quick distinction between the four types. This nomenclature problem, which is serious, will be discussed next month.

Arthur M. Merrill
Editor

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Visco-Mechanical Concept of Plastics Testing

Dynamic testing correlates polymer strength properties with molecular weight, permitting quick evaluation of long-term behavior.

LEROY A. DARLING, *Group Leader, Materials Laboratory, Sperry Gyroscope Co., Great Neck, N.Y.*

In the past 25 years, there has been a remarkable expansion in the production and use of synthetic plastics. One of the chief reasons for this expansion is the very wide range of mechanical properties exhibited by high polymers, permitting them to be used as rubbers, textile fibers, and films, and for structural purposes.

In many cases the usefulness of the plastic is dependent upon its mechanical properties and, therefore, it is subjected to a great number of physical tests. Many of these tests, although they have been in use for several years, tell very little about the fundamental nature of the material and offer no correlation between test results and actual molecular structure. Some of this inadequacy results from the test applied having been adapted from techniques used for other substances, such as concrete, paper, leather, or steel.

Recent work in the field, particularly at Massachusetts Institute of Technology, Brooklyn Polytechnic Institute, and Princeton University, has shown that loading rates, time scale, and viscoelastic behavior are very significant in strength tests. Tests run at the extremes of the time scale are very important. These long-term tests include stress relaxation, permanent deformation, creep, and long-time strength. In addition to giving the design engineer much useful information, these tests provide the theoretical chemist with data which helps determine the molecular structure of the plastic in question.

Recently, a new technique called "dynamic" testing has been evolved and, in general, has come to be associated with the measurement of the response of a specimen to periodic or mechanical vibration. At present, electrically stimulated apparatus seems to offer the best results.

In this paper, an attempt will be made to present phenomenological and molecular interpretations of the mechanical behavior of plastics. A discussion of viscous and plastic flow and simple viscoelastic behavior is first presented, followed by comments on the molecular

LeRoy A. Darling received a B.S. in chemistry in 1945 from the University of Maine, and an M.S. in chemistry in 1952 from Brooklyn Polytechnic Institute, where he is now taking advanced courses toward his Ph.D. He has taught courses in plastics at the Farmingdale Institute and the Polytechnic Institute. He is a member of ACS, SPE, Phi Lambda Upsilon, and Sigma Xi.

Mr. Darling came to Sperry in 1945 as an assistant project engineer, working on general process developments in organic chemistry. In 1946, he was reclassified as a chemist and assigned to his present department. Since that time, his primary duties have been process development and research in the field of high polymer chemistry, with special emphasis on the applications of polymers in electronic components for use at all ambient temperatures. His current projects are research and process development on new high polymers, and their applications to elastronic packaging, dipping resins, and high temperature resistant adhesives.

Fig. 1 Mechanical representation of a visco-elastic system showing a spring and dashpot in connected series.

showing a spring and dashpot in connected series.
mechanism involved in simple elastic and viscous deformation.

Elastic and Viscous Behavior

Plastics, when loaded, behave in a manner intermediate between that of a Newtonian fluid and an elastic solid. The Newtonian or viscous fluid supports a stress which is proportional to the time rate of change of strain.

Deformation for the "elastic" solid is independent of time, is immediately and completely recoverable upon removal of stress. The strain is proportional to stress, $S=GE$, where G is the shear modulus of elasticity and E is strain or unit deformation.

Using the "model" method of representation, a viscoelastic system can be shown as in Figure 1. This mechanical analogy of a spring and dashpot in series serves as an additional illustration of the strength behavior of plastics. The idealized spring will always deform elastically, while the dashpot will always deform in a viscous manner. Such a system is time-dependent, thus at high loading rates it behaves in an elastic fashion and the viscous dashpot has little opportunity to deform.

Very low loading rates favor viscous flow in the system in addition to the elastic deformation which is proportional to the load. It is only when loading rate is of the same order of magnitude as n/G that composite rating of the deformation becomes apparent. It now becomes clear why tests at the extremes of the time scale provide the most useful theoretical and engineering information. Rapid tests indicate the elastic characteristics; slow tests show viscous behavior. The effect of loading rate is shown in Figure 2.

In the preceding, we have considered the case where total deformation is the sum of elastic deformation and viscous flow. Now, we will consider the case where the elastic response is delayed by viscous resistance to deformation. A typical molecular mechanism which should be expected to result in such retarded elasticity

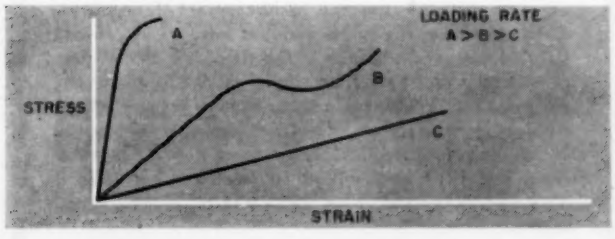


Fig. 2 Typical stress-strain curves showing the effect of increased loading rate on plastic behavior.

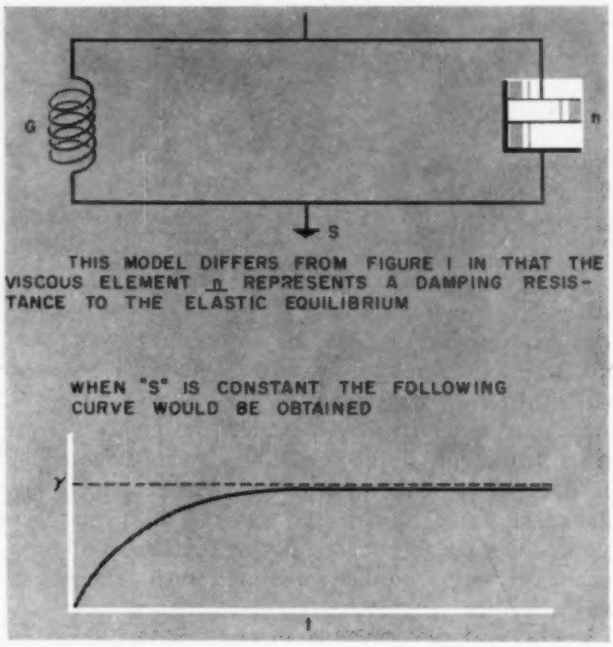
is the uncurling of long chain polymer chains. Using our system of "models," this retarded elastic response can be represented as shown in Figure 3.

The following differential equation governs retarded elastic response:

$$G\gamma + N\ (d\gamma/dt) = S$$

where G is the shear modulus of elasticity, γ is the strain, and S is the stress. The quantity n/G is the "retardation" time, r. Therefore, it can be seen that a retarded element relaxes exponentially into its equilibrium shape at a rate determined by its r value.

The rate of stress application plays an important part in the behavior of a retarded elastic element as well as in a Maxwell element. If a constant stress is applied for a time which is very short compared with the "retardation" time r, then only the first part of the deformation-time curve is observed, and the material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THIS MODEL DIFFERS FROM FIGURE 1 IN THAT THE VISCOUS ELEMENT η REPRESENTS A DAMPING RESISTANCE TO THE ELASTIC EQUILIBRIUM
WHEN "S" IS CONSTANT THE FOLLOWING CURVE WOULD BE OBTAINED
γ
t

Fig. 3 Model illustrating retarded elastic response.

behaves like a simple fluid of viscosity n. If the constant stress is applied over a very long period compared to the retarded time, the deformation and recovery will appear to be instantaneous.

Only when the experimental conditions are such that the time scale of stress application is comparable to the internal time scale of the material are both the elastic and viscous aspects observable. Any two elements coupled in series individually bear the entire stress, and their deformations are additive. Any two elements coupled in parallel will exhibit the same deformation, but they divide the stress between them.

Thus far in this discussion on elasticity, inertial effects have been neglected. One of the most important new developments in strength tests, and one which may shed some light on the "roughness" problem, is "dynamic testing." Dynamic testing has come to be associated with measurement of the response of a specimen to mechanical vibration or periodic forces.

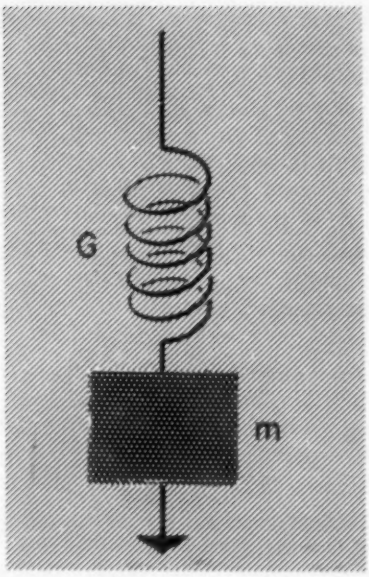

Fig. 4 Mechanical representation of elasticity plus a lumped inertia shown in the form of mass (m).

Figure 4 is a mechanical model representing elasticity plus a lumped inertia. For this model, there is one component of homogeneous stress, one component of homogeneous strain, and the inertia is considered lumped together. The strain γ is no longer given as $S = G\gamma$, but now is given by the differential equation:

$$S = G + m(d^2\gamma/dt^2)$$

The term $m(d^2\gamma/dt^2)$ is an expression of mass times acceleration, and is an inertial term proportional to the density. If a stress S, is applied suddenly $(t = O)$ to a material possessing both elasticity and inertia, it does not immediately give an equilibrium deformation $\gamma = (1/G)S_1$, but rather oscillates back and forth between the values O and $2\gamma_1$. Generally, this oscillating is damped out by the internal viscous resistance. Therefore, the general equation becomes:

$$S\ (t) = G + n(d\gamma/dt) + m(d^2\gamma/dt^2)$$

The model shown in Figure 5 represents this mechanically, while Figure 6 shows a model having two elastic elements and two viscous elements; the n_3 being an element of flow. The following equations can be set up using the symbols given in Figure 5:

$$S = G_1\gamma_1$$
$$S = G_2\gamma_2 + n_2(d\gamma_2/dt)$$
$$S\ (=)\ n_3(d\gamma_3/dt)$$
$$\gamma = \gamma_1 + \gamma_2 + \gamma_3$$

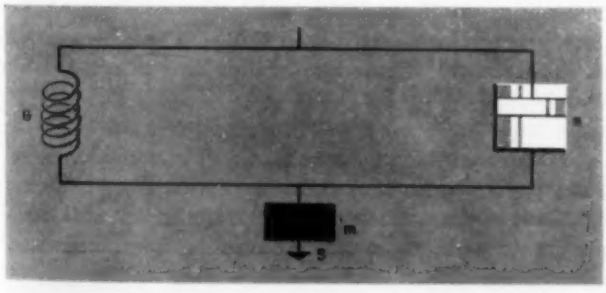

Fig. 5 Damping effects of internal viscous resistance.

After differentiating and addition, the final expression for internal viscous or flow displacement resistance becomes:

$$n_2(d^2\gamma/dt^2) + G_2\ (d\gamma/dt) = G_2S/n_3 + \gamma\ (ds/dt) + B(d^2s/dt^2)$$

where $B = n_2/G_1$

For ordinary static and nearly static mechanical tests such as ASTM tensile, shear, etc., the damped inertial character of the elasticity can be disregarded. It is only for very rapid dynamic experiments that this characteristic cannot be ignored.

Strength tests, properly chosen, are of great value in studying the molecular structure of polymer systems. Creep and relaxation data have made it possible to estimate the degree of cross linking and branching. Dynamic test data also have been useful in transition and molecular configuration studies.

Effect of Molecular Structure on Strength Properties

The macroscopic elastic behavior of a crystal is the result of forces acting between neighboring molecules or atoms. Distortion of the whole crystal forces neighboring atoms away from their original equilibrium positions. In an atomic lattice, the interatomic forces are covalent bonds, and have a pronounced directional nature.

In a molecular lattice, several different kinds of interparticle force must be considered. Deformation of individual molecules involves stretching or compression of primary valence bonds, and opening or closing of valence angles. Relative displacement of whole molecules is opposed by intermolecular van der Waals forces. When a shear stress is applied to an amorphous polymer, there is some flow similar to a liquid. Since the polymer segments are strung together in chains, this flow, although rapid at the start, slows down as the polymer molecules are strung out into elongated shapes. Further motion can take place only as whole molecules slowly shift their centers of gravity. When the stress is released, the elongated molecules diffuse back into their half-curled shapes. This represents an elastic recovery of part of the original apparent flow.

The mechanical behavior in shear of a low molecular weight liquid or glass is made up of two parts; flow or biased molecular diffusion, and an instantaneous elastic response. In the case of an amorphous high polymer, the biased diffusion alone results in a twofold mechanism: configurational elasticity which arises from biased micro-Brownian motion (1);* and the permanent flow which arises from the biased macro-Brownian motion.

In addition, the amorphous polymer must exhibit the same type of instantaneous elastic response independent of any diffusion process, as does simple glass. Even if no polymer segment in the entire sample jumps to a new equilibrium position, the whole structure can be deformed slightly when a stress is applied. Valence

* T. Alfrey, "Mechanical Behavior of High Polymers." Interscience Publishers, Inc., New York, N.Y. (1948).

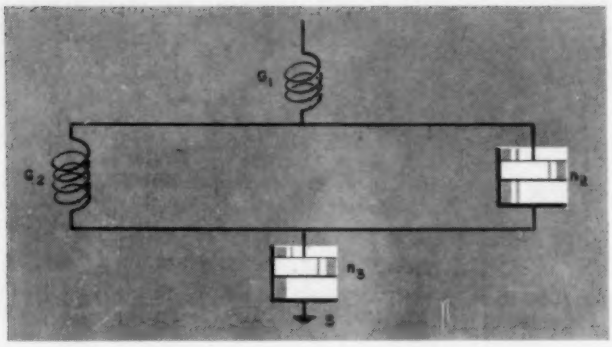

Fig. 6 Model with two elastic and two viscous elements.

bonds are stretched or compressed, valence angles are opened or closed, and near molecular neighbors are moved closer together or farther apart against the action of intermolecular forces.

This mechanical behavior is represented in Figure 6. This model is quite oversimplified. In the first place, the flow element does not necessarily represent a Newtonian flow characterized by a viscosity coefficient alone. The internal viscosity also may be non-Newtonian. The elastic element may be non-Hookian, in that the equilibrium elastic strain may not be simply proportional to the stress.

When a stress is applied to an amorphous polymer, three types of deformation take place; instantaneous elastic response, retarded elastic response, and flow. When the imposed deformation rate is very high, the elements of retarded response and flow are unable to show themselves to any extent, so the material behaves like an ideal elastic body. If the imposed deformation rate is very slow, the material simply exhibits flow.

Therefore, if the cross-head speed of the tensile tester is in the range where the material exhibits only elastic response, moderate changes in speed should not substantially change the shape of the stress-strain curve. However, if the response of the material is plastoelastic, changes in the loading rate will result in changes in the stress-strain curve. The initial slope of the curve, which would be apparent modulus, will always increase with increasing rate of strain, making the material appear stiffer than it is. It should be noted here that permanent and irreversible changes in the polymer molecular structure take place long before actual failure occurs.

In keeping with the interest in dynamic measurements, the behavior of the material represented in Figure 6 when subjected to a sinusoidal stress, may be considered. In the steady state, the samples will have a sinusoidal deformation, and an amplitude which depends upon both the magnitude and the frequency of the stress. Many times, especially for cross-linked polymers, the flow term becomes quite small and can be neglected.

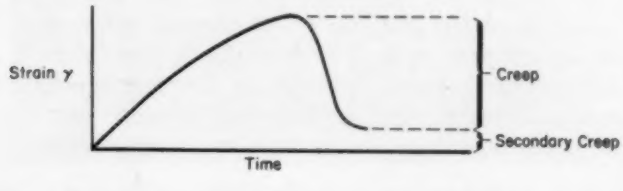

Fig. 7 Strain time curve showing creep of a polymer.

Figure 6 represents a mechanical analog of this type of behavior. G_2 and r represent the retarded response caused by the uncurling of molecular chains. The n_2 and n_3 elements become so large that where a stress is applied, the material responds as an elastic body. So-called "cold flow" is the result of a stress being applied for a long time. At very high temperatures, the material behaves as a liquid having a viscosity n_3. The elastic response and retarded elasticity still operate, but are obscured due to the extremely large flow.

As the time scale has been assumed to be held constant, similar shifts in the values of n_2 and n_3 can be brought about by holding the temperature constant and changing the experimental time scale. It can be shown that the retarded element will give an instantaneous elastic response, both in deformation and recovery, if the retardation time is much less than the time scale. When the retardation time is much greater than the time scale, the retarded element G_2 will appear to flow and to have a viscosity n. It is only when the retardation time is approximately equivalent to the time scale that the retarded element exhibits its complete character.

If we plot strain against time, the curve shown in Figure 7 is obtained. This secondary creep is the property that is obtained when the usual ASTM test is performed on materials.

It is apparent that the obvious mechanical value of a polymer depends strongly upon its relative magnitudes of G_1, G_2, n_2, and n_3. At very low temperatures, n_2 and n_3 are so large that the material behaves as a simple elastic material of modulus G_1. At higher temperatures, n_2 and n_3 are small, so the material will have a rubbery character. At still higher temperatures, the material will appear to flow as a simple viscous liquid.

Time-Scale Considerations in Testing

When a plastic is loaded in a tensile machine, such as the Baldwin-Tate-Emery Universal testing machine (see Figure 8) and a stress-strain curve determined, the stress cannot be held constant but increases until the yield point of the material is reached. Therefore, rather than try to hold stress constant, the rate of elongation usually is held constant by regulating the head-speed of the machine.

If the elongation proceeds to a high value, the cross-sectional area of the sample is reduced significantly. As a result, the stresses calculated from the original cross-section are quite different. The stress-strain curve has a different shape from the directly observed "load-elongation" curve, and is comparable to an elongation-time curve at constant stress, while the load-elongation curve is equivalent to an elongation-time curve at constant load.

An ideal elastic material responds to a stress by instantaneously taking on a new equilibrium shape. Thus, shear stress equals the strain multiplied by the elastic modulus. When such a material is deformed at a constant rate, the stress-strain curve is a straight line through the origin, and is independent of the rate of straining.

The dependence of the tensile strength of a high polymer upon chain length is qualitatively the same for all polymers. A polymer of very low molecular weight is extremely weak. As molecular weight increases, tensile strength also increases. For a portion of the curve, strength is roughly proportional to molecular weight, but the curve relating the two quantities levels off later. After a certain molecular weight is reached, further increases in molecular weight do not result in significant improvements in strength. Other mechanical properties closely related with ultimate tensile strength show the same general sort of dependence upon molecular weight.

Table 1 was prepared from tensile strength and ultimate elongation tests on samples of polymethyl methacrylate having various molecular weights run in the author's laboratory and elsewhere.**

Table 1. Effect of Molecular Weight on Strength Properties of Polymethyl Methacrylate.

Molecular Weight	Tensile Strength, psi.	Elongation, %	Strain When Crazing Starts, micro-inches
90,000	6,600	1.8	2.0
100,000	8,300	2.78	2.4
200,000	10,000	4.71	2.6
500,000	10,000	5.85	2.95
3,000,000	10,250	6.04	3.82

Specimens prepared according to ASTM D638-49T gave the tensile, elongation, and craze point results presented. All values are averages for each of the specimens tested.

Figure 9 shows graphically the change in tensile strength and the start of crazing versus molecular weight. In all cases, tensile strength increased rapidly with increasing molecular weight up to a molecular weight of approximately 200,000. At this point, the tensile strength levels off. The total elongation also increases rapidly with increasing molecular weight up to approximately 500,000, and then levels off. Both the stress and strain at which crazing occurred in the standard tensile tests increased with increasing molecular weight.

The stress-strain diagrams did not vary with molecular weight, except at the breaking point. The brittle nature of the low molecular-weight samples was seen in the solvent crazing test. This showed that specimens of low molecular weight always ruptured immediately upon crazing.

The hypothesis that the strength of a typical polymer would go up with increased molecular weight was borne out in these qualitative results. In a polymer of low molecular weight, the forces required to cause adjacent chains to slide relative to each other are quite weak due to the short length of the chains and the subsequent

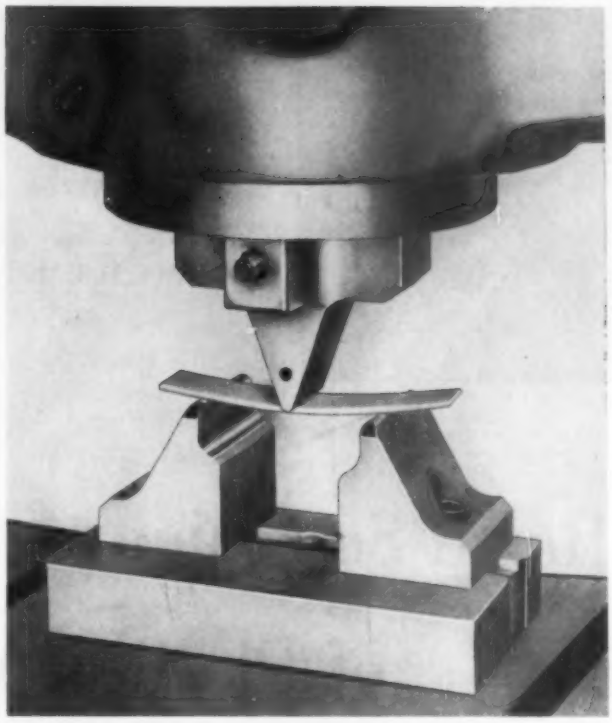

Fig. 8 Plastic specimen being subjected to a static stress test.

small number of secondary valence linkages. As the molecular weight increases, the resistance to sliding of adjacent chains increases until it becomes easier to cause rupture by the breaking of primary valence forces than by larger chains sliding past one another. Thus, the specimens with the lowest molecular weights break at relatively low loads.

A great number of plastic materials, including laminates, moldings, and castings (both thermosetting and thermoplastic), have been evaluated in our laboratory. New tests are being devised in this laboratory which will help to correlate structures with the physical test data obtained, and permit predicting the behavior of the plastic material in other unrelated tests, thus enlarging the scope of use of these materials.

With such tests, if properly designed, a few hours testing will allow prediction of ultimate behavior over longer periods of time. Many rubber and plastic materials are used in modern equipment, and it is impor-

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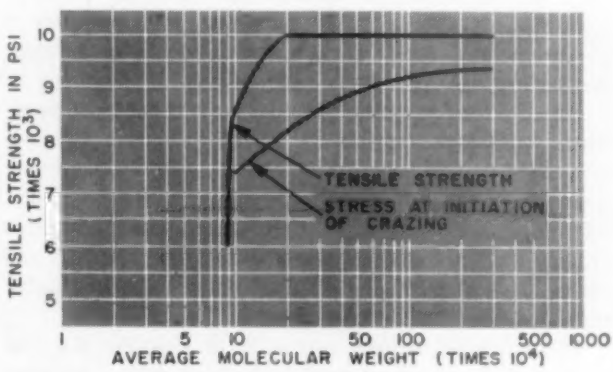
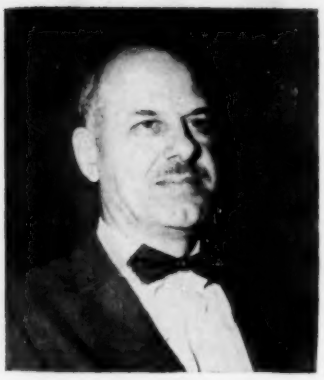


Fig. 9 Curves showing the change in tensile strength with molecular weight of various substances.

** E. A. Hauser, "The Effect of Molecular Weight Distribution on the Physical Properties of Polymethyl Methacrylate," M.I.T., P.M.M.A., Plastic Project Report (1950).



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Rapid Screening of Plastisol Viscosity Depressants

A simple, rapid test is described for evaluating additives used to depress PVC plastisol viscosity.

Plastisols are dispersions of finely divided resins in plasticizers. Upon baking, these plastisols fuse to yield flexible compositions. They are adaptable to the preparation of surface coatings, impregnating compositions, and cast products. They are versatile materials in that they can be spread, dipped, cast, foamed, or sponged.

Certain surface-active agents (surfactants) have shown an unique ability to appreciably lower the viscosity of plastisols, both initially and upon storage. Referred to as plastisol viscosity depressants, these agents impart their action to polyvinyl chloride and other paste resins when present in relatively small amounts (0.5-2 parts PHR).

The technique of lowering a plastisol's viscosity by the addition of such a viscosity depressant is a valuable tool, for it permits the employment of a higher ratio of resin to plasticizers available to the formulator; allows higher filler and pigment loadings; and provides a handy method for obtaining and controlling viscosity on the low side.

Faced with the task of evaluating a number of products as plastisol depressants for PVC resins, a simple procedure has been worked out for rapidly screening products for their ability to reduce plastisol viscosity. The test is run on a small scale; only about 100 grams of raw material are needed for the test sample, and viscosity measurements are run on only a few cubic centimeters of finished plastisol.

The purpose of this article is to describe the test method and report on results obtained with a number of viscosity depressants, including several commercial products used as reference controls.

Test Procedure

The procedure consists of two parts; (1) preparation of the plastisol, and (2) measuring the viscosity of the plastisol both initially and after aging. These operations will be discussed in turn.

Preparation of Plastisol

Plastisols were prepared in accordance with the following formulation, using Geon 121 Paste Resin for the PVC resin, and measuring out the viscosity depressant by means of a graduated pipette:

Polyvinyl chloride resin	58.5 gm. (41.8 cc.)
Plasticizer	41.5 gm. (42.1 cc.)
Viscosity depressant	0.6 cc.

The amount of additive in this formulation corresponds to about one gram of viscosity depressant for each 100 grams of PVC resin in the final plastisol.

After the viscosity depressant additive is dispersed in the plasticizer, the resin and treated plasticizer are preblended wth a spatula, using a minimum of mixing. The blend then is charged into a miniature ball mill (see Figure 1). Described in a recent article*, this mill consists of a small, closed cylindrical can containing ⅛-inch ball bearings. After charging, the ball bearings and plastisol are stirred gently to permit the escape of any entrapped air.

The mill then is covered and positioned in a commercial paint shaker. By use of a suitable holder as-

*B. R. Orwig, "The Quickie, A High Speed Ball Mill for the Paint Laboratory," **Offic. Dig. Federation Paint & Varnish Production Clubs**, 830 (Sept. 1954).

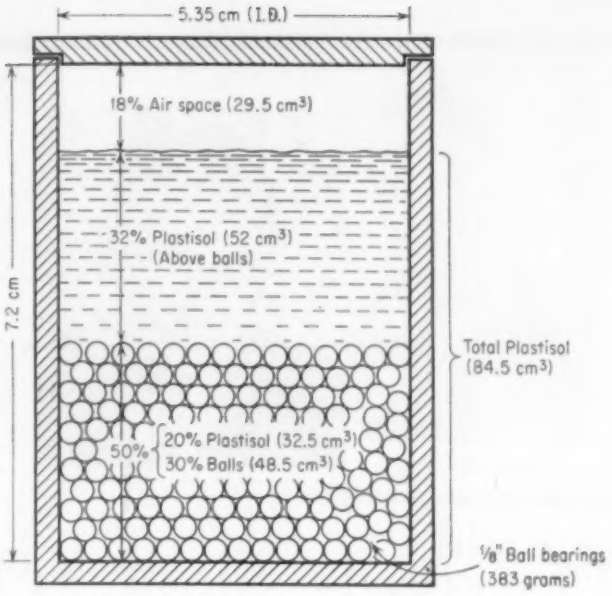

Fig. 1. Cross-section of miniature ball-mill and plastisol charge.

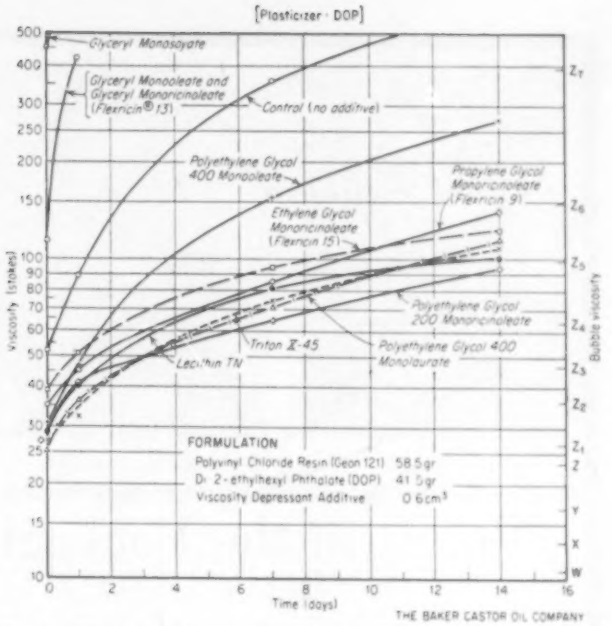

Fig. 2. Effect of aging on viscosity of PVC plastisol plasticized with DOP.

sembly, the shaker can run four mills simultaneously. A homogeneous plastisol results after 15 minutes of agitation in the shaker (five minutes in original position, five minutes with mill turned upside down, and five minutes with mill returned to original position).

After mixing, the mill is removed from the shaker and let stand for five minutes. At this point, the plastisol is checked for height of foam development and bubble size. After straining the plastisol into a glass beaker, a five-cubic centimeter portion is poured into a 25-cc. graduated test tube. By means of a heavy-duty mechanical vacuum pump, a vacuum is applied to this test tube in order to check the plastisol's level of upsurge and the texture of bubble formation.

This method of plastisol preparation has the advantages of requiring only a small quantity of plastisol material; producing a constant amount of mechanical agitation; and introducing air from a constant-volume air space in the can above the plastisol. Except for some initial hand mixing necessary to introduce the plasticizer (and additive) into the paste resin, the entire mixing process is completely mechanical and free from manual influence.

Viscosity Measurement

After draining the plastisol from the miniature ball mill and deaerating it for 15 minutes, a small portion is introduced into a Gardner bubble-viscosity tube similar to those used in the protective coatings industry for measuring the viscosities of clear vehicles. An obvious objection to using the bubble method of measuring the viscosities of somewhat opaque plastisols would be that the bubble could not be observed readily. However, by directing a bright beam of light through the tube from behind and viewing the tube from in front, with light blanked out from either side of the tube, the rise of the bubble can be followed readily, especially since its upward movement is relatively slow. The viscosity of the plastisol is measured periodically in terms of bubble viscosity over a time period up to 14 days, and the viscosities are plotted as a function of time.

Test Results

Figures 2 and 3 give graphs of typical results obtained with a selection of viscosity depressants. In Figure 2 the plasticizer is di-2-ethyl hexyl phthalate (DOP), where as in Figure 3 the plasticizer is n-decyl octyl phthalate. As expected, DOP gives consistently higher plastisol viscosities because of its greater solvating power for PVC resin.

In this study, a number of established viscosity depressants, as reported in trade and industrial literature, were selected first for evaluation. The work then was extended to cover a group of materials (mono-esters and polyoxyethylene esters) which appeared to be indicated for this type of application on the basis of their chemical structure.

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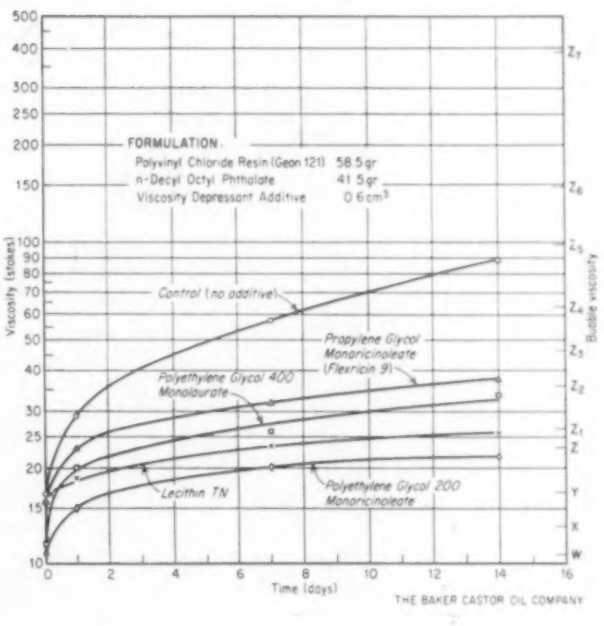

Fig. 3. Effect of aging on viscosity of PVC plastisol plasticized with n-decyl octyl phthalate.

Guest Editorial

Vinyls in the Packaging Field

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The field of packaging, opened to vinyls comparatively recently, already promises to be one of the most important for this tough, low-cost plastic. For years, the vinyl family of materials was scarcely heard of in packaging except as a coating or laminating material. A great deal of work is being done to improve vinyls from a strictly packaging standpoint, and with ever-increasing compounding knowledge and improvement of quality, the material has become of far greater value to packaging.

In former years, the types of plasticizers and compounding ingredients then available presented problems of taste, odor, and toxicity which were thought to bar vinyl films from food and other sensitive products. In 1946, however, the use of nitrile rubber as a plasticizer resulted in a film so free of these defects that it could be used in the packaging of food. Since that time, the chemical industry has developed lower cost chemical plasticizers with a low odor and taste level which have been accepted as non-toxic by the Bureau of Animal Industry. Such developments should greatly increase the use of vinyl films for food as well as other types of packaging.

Vinyl packaging materials fall into three general classes; films and sheetings, laminates, and coatings. Films and sheetings can be made hard and brilliant, approaching cellulose acetate in appearance, or they can be soft and flexible, with a texture similar to polyethylene. They can be made in varying degrees of transparency, including completely clear or they can be opaque. Production methods include calendering, casting, and the more recently developed extrusion method.

Laminates serve as a moisture barrier to protect equipment during storage and shipment to both tropical and frigid climates. The principal barrier material consists of a laminate of vinyl film, aluminum foil, polyethylene film, and cotton scrim. Vinyl film imparts excellent heat sealability, crease resistance, and overall toughness to the laminate.

The third class, coatings, uses vinyl copolymers which are made into solvent-type coatings and into dispersions. For packaging purposes, application is usually by roll or knife coating, although spray application is used in certain cases. Vinyl coatings are characterized by extreme flexibility, absence of ordor, adhesion, non-blocking abrasion and scuff resistance, and oil and grease resistance.

In all forms, vinyls have outstanding virtues for packaging. The material is tough and strong; it can be heat sealed; it can be made with excellent clarity; and it has high resistance to oils and greases. Flexibility ranges from rigid to very soft and pliable. Toxicity, odor, and taste characteristics are excellent, but extreme care must still be taken to select the proper plasticizer-resin combination to meet these requirements, and to prevent migrating of plasticizer under certain conditions.

The application of vinyl packaging materials are many and varied. Films of non-toxic composition are used for packaging such diverse products as milk, lard, essential oils, moisture cups, syrup concentrates, and pickles. In the toiletry field, cosmetic cases and toilet kits are being made of opaque, translucent, or transparent vinyl sheeting.

Rigid vinyl sheeting may be drawn and formed

(*Continued on page 28*)

Dwight E. Peerman

William S. Mitchell

Don E. Floyd

Polyamide-Epoxy Combinations as Structural Adhesives*

Properties of adhesives made by reacting polyamide and epoxy resins indicate their suitability for structural applications.

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DON E. FLOYD, *Products Application Section*
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WILLIAM S. MITCHELL, *Market Development Dept.*
Chemical Research Dept., General Mills, Inc.,
Minneapolis, Minn.

Polyamides have been used for many years in many types of adhesive formulas. As a class of polymers, they are noted for adherence, strength, and toughness. One type of polyamide, called nylon, is known for its high tensile strength and fiber-forming characteristics. Other types, manufactured by General Mills, also have excellent strength and toughness, but are better known as thermoplastic or heat-seal adhesives rather than as fiber-forming materials.

Our Versamid polyamide resins are products of the condensation of polymerized fatty acids and polyamine compounds. They have been used for many years in the packaging industry as heat-seal adhesives for flexible packaging (1,2).** Some of the physical properties of these resins are given in Table 1.

More recently, polyamide resins of another type have been introduced by General Mills. These products react with epoxy resins to form thermoset polymers that combine many of the good features of both polyamides and epoxies. The excellent adhesion of these formulas as surface coatings already has been reported (3).

It is the purpose of this paper to describe the new structural or load-bearing adhesives which can be formulated from thermoset combinations of General Mills' Versamid polyamide resins with epoxy resins (4).

Polyamide resins contain polar amine, carboxyl, and amide groups as a natural consequence of their preparation by condensing molecules containing amine and carboxyl groups. It is well known that this kind of polarity contributes greatly to adhesion to many surfaces. For example, Felix Braude (5) states that polar adhesives are generally suitable for adhering polar materials, whereas they are not as suitable for use with non-polar materials. This concept undoubtedly helps to explain why polyamide or polyamide/epoxy adhesives do not adhere well to such non-polar surfaces as polyethylene and Teflon. On the other hand, they adhere strongly to most metals, wood, leather, glass, and many plastics.

* Based on a paper presented before the ACS Division of Paint, Plastics, and Printing Ink Chemistry, Minneapolis, Minn., Sept. 15, 1955.
** Numbers in parentheses refer to bibliography at end of article.

Table 1. Properties of Versamid Polyamide Resins

	Versamid 90	Versamid 93	Versamid 94	Versamid 95	Versamid 100	Versamid 115
Viscosity at 25° C. (Gardner-Holdt)	A-C**	C-E*	A-C*	A3-A*	A-C*	—
Color (Gardner), max.	12	12	12	12	12	12
Acid no. (approx.)	7	7	7	7	7	7
Max. ash, % by wt.	0.10	0.10	0.10	0.10	0.10	—
Specific gravity	0.98	0.98	0.98	0.98	0.98	0.99
Softening point Ball & ring, ° F.	173-190	105-115	105-115	95-105	43 min.	—

* 35% solution in butanol-toluene (1:1)
** 25% solution in butanol-phenol (1:1)

Polyamide/epoxy adhesives are classified as structural materials. Structural adhesives are assuming a more and more important part in every-day life. George Epstein (6) states, "from an industrial standpoint, adhesive bonding is yet in its infancy. If the rapid growth demonstrated thus far for this joining technique is indicative, then it is quite likely that adhesive bonding may one day surpass in importance all other techniques for permanently joining materials." The pioneer in structural adhesives has been the English aircraft industry. In the United States at the present time, structural adhesive joining is coming into greater and greater prominence.

The new, thermoset polyamide/epoxy structural adhesives should be of particular interest to the aircraft industry. They display many of the excellent characteristics of amine-cured epoxy adhesives and, in addition, have certain inherent advantages. They have the same high degree of structural strength, but coupled with this is an improved resistance to impact or mechanical shock. These new adhesives exhibit a longer pot life; consequently, are easier to handle and give the fabricator more time in which to work.

Because of the higher viscosity of polyamide/epoxy compositions, there need be less concern about flow from vertical surfaces. By the addition of thixotropic agents, these adhesives may be made completely non-flowing and yet have excellent spreading or trowelling properties. Because the polyamide and epoxy resins are used in approximately equal quantities, formulations are less sensitive to mechanical error than are amine-cured compositions.

Polyamide/epoxy adhesives tend to be sticky in the uncured stage and, for that reason, will hold materials together until final cure is achieved. It should be noted also that there have been no reported cases of dermatitis or other toxic symptoms attributable to the use of polyamide resins.

General Mills does not manufacture formulated structural adhesives, nor does it manufacture epoxy resins. It does market a number of commercial grades of Versamid polyamide resins which can be combined with epoxy resins to give structural adhesives having the above advantages. The primary purpose of this paper is to bring to the attention of adhesive users information on the use of polyamide resins in combination with epoxy resins as structural adhesives.

Testing Procedures

As is well known among those skilled in formulating and testing adhesives, it is difficult to compare adhesive testing results from one laboratory to another, even when the tests have been performed on one type of material. There are many variables; the techniques of surface treatment, the substrate, bonding techniques, testing methods, and other variables are sufficiently variable that a valid comparison can be extremely difficult.

In order to compare materials, it is necessary to include control formulas and to define conditions as closely as possible to establish a basis for such comparisons. For this reason, in our experimental work we have included the test results for a commonly-used formulated adhesive, which will be referred to hereafter as the best commercial adhesive tested.

All tests included in this report, unless otherwise designated, were conducted on 24ST aluminum, 0.064-inch thick. Specimens were bonded one inch wide, with a ½-inch overlap, and were prepared as specified in Military Specification MIL-A-5090B. Light sanding was the only pretreatment of the aluminum in the cases reported.

It is possible, of course, to apply other pre-bonding treatments, such as chromate or alkaline etching. Since the purpose of this study was not to present a final system of bonding, but to compare different adhesive formulas, one pretreatment (sanding) was used in all cases. The only pressure used was that necessary to form a glue line thickness of between 1-2 mils.

In addition to the work on structural adhesives presented here, it should also be noted that polyamide/-epoxy adhesives can be formulated to have excellent peel strength. These are obtained by increasing the ratio of polyamide to epoxy resins in the formulation, but there is some sacrifice of structural rigidity as the polyamide resin content is increased.

Formulations

To determine the optimum ratio of polyamide resin to epoxy resin for the adhesives outlined in this paper, the strength properties of cured combinations in various resin ratios were studied. Properties such as hardness, tensile strength, compressive strength, flexural strength, and heat distortion temperature were used as criteria in choosing the optimum ratios of ingredients.

Table 2. Effect of Amount of Filler on Adhesive Tensile Shear Strength (Composition: Versamid polyamide resin, 115; ERL 2795 epoxy resin; ratio 1:1)

Filler		Shear type tensile strength, psi.		
Type	Quantity, PHR	Room Temp.	At 250° F.*	After mech. shock of 80 in.-lbs.
Tabular Alumina	20	3,200	2,560	2,940
	60	3,080	—	1,060
	100	2,960	2,070	440
Surfex MM	20	2,730	1,620	2,240
	60	3,200	—	300
	100	3,400	1,430	130

*Specimens tested after five minutes conditioning in an ambient temperature of 250° F. Lower results can be expected after longer exposures, or when bond temperature reaches 250° F.

The premise that optimum strength properties in the cured resins would carry over to give the optimum strength properties in the adhesives (7) was corroborated by adhesive testing. If ratios other than those given with the particular epoxy resins were used, certain properties such as resistance to elevated temperature usually fell off noticeably.

In the course of this study various fillers were examined for their contribution to adhesive strength. Table 2 summarizes the results of this evaluation of fillers. It will be noted that the amount of filler, regardless of type, has a marked effect on adhesive strength. It will also be noted that the type of filler has an effect on the adhesive strength.

These are not new findings, since the effects of fillers in adhesives have been reported by Elam (8) and Epstein (6). In general, fillers are known to increase the modulus adhesive, modify its coefficient of thermal expansion, control its shrinkage, and increase its viscosity, impact strength, and resistance to heat.

The role of the filler in formulating a successful adhesive is, obviously, of the utmost importance. In this paper, no attempt has been made to exhaustively screen the innumerable types of fillers that are available. A large number of fillers have been tested, however, and several have been selected as being the best of those tried. Of course, the optimum filler content may vary with the individual filler used in each case.

Experimental Results

The adhesives in this paper were tested in accordance with the methods prescribed in ASTM D1002-52T and MIL-A-5090B. Among the results included are measurements of tensile shear strength at 80, 250, and —104° F. Standard temperature bend strength; the effects of proprietary materials, including hydraulic fluid, motor oil, JP4 fuel, tap water, and salt spray; and resistance to accelerated weathering also are included.

The resistance of one adhesive composition to environmental factors is shown in Table 3. The adhesive contained Versamid 115, Araldite 502 epoxy, resin, and tabular alumina filler in a ratio of 2:3:1.

Also included in this paper is a newly devised test which we have called mechanical shock resistance. This new test is conducted by subjecting the bonded area to a known impact and immediately testing the tensile shear strength of the adhesive. It is shown in Table 4 that as the impact is increased, the specimen is damaged sufficiently to demonstrate a reduction in tensile shear strength.

In the case of the best commercial adhesive tested, the reduction in strength was rapid. This points to a particular advantage of the polyamide/epoxy adhesives over the amine-cured epoxies in that the former have unusual ability to absorb shock without undergoing serious damage. This is apparently a result of the internal plasticization of the polyamide when used as a co-reactant with epoxies

Interaction between the polyamide resin and the epoxy resin effects a cure to a thermoset condition in which both polymers participate. This is not simply a physical blend of two ingredients, but is a product of chemical reaction between the amine groups of the polyamide and the epoxy groups of the epoxy resin.

Since the reaction of polyamide and epoxy yields a three-dimensional or cross-linked polymer, the strength properties and the resistance to proprietary materials are excellent.

The polyamide acts as a permanent plasticizer since it becomes an inherent part of the cured adhesive. It is a plasticizer in the sense that it improves mechanical shock resistance and helps to distribute the load over the entire bonded area. On the other hand, it does not seriously detract from the rigidity, nor does it detract at

Table 3. Adhesive Resistance to Environmental Factors

MIL-A-5090B Exposure	Ultimate Tensile Shear Before Exposure, psi. (Average of 5)	Ultimate Tensile Shear After Exposure, psi. (Average of 5)
Salt spray, 250 hrs.	3,130	2,050
Isopropanol, 7 days	3,200	3,000
Hydrocarbon, 7 days	3,270	3,300
Hydraulic oil, 7 days	3,160	2,770
Weather-o-meter, 60 hrs.	2,440	2,680
JP4 Fuel, 7 days	2,440	2,680
Tap water, 30 days	3,130	2,600

Table 4. Effect of Impact on Adhesive Tensile Shear Strength

Composition	Tensile Shear Strength, psi. No Impact	40 in.-lb. Impact	60 in.-lb. Impact	80 in.-lb. Impact
Polyamide/epoxy +20% AFD filler	3,420	2,870	2,460	2,250
Polyamide/epoxy +50% atomized aluminum	3,030	2,930	2,840	2,780
Best competitive adhesive	3,490	2,850	950	660

Table 5. Adhesive Bend Strength (MIL-A. 5090B)

Composition	Average Load at Failure, lbs.
Versamid 115:ERL-2795:AFD (5:5:2)	201
Versamid 115:ERL-2795:Tabular Alumina (5:5:2)	194
Versamid 115:ERL-2795:Atomized Aluminum (5:52)	182

Table 6. Tensile Shear at Various Temperatures. Adhesive composition—Versamid polyamide 115:ERL-2795 epoxy: Filler (5:5:2).

Filler	Room Temp.	250° F.*	—104° F.
Tabular alumina	3,200	2,560	3,460
AFD	3,420	2,980	3,030
Atomized aluminum	3,030	1,420	—
Iron oxide (100%)	3,070	2,830	—
Best competitive adhesive tested	3,490	2,550	—

*Specimens tested after five minutes conditioning at an ambient temperature of 250° F. Lower results can be expected after longer exposures or when bond temperature reaches 250° F.

all from the structural strength. This is apparent from the data presented in Tables 5 and 6.

The adhesion of this system to many surfaces is excellent. These surfaces include common metals such as aluminum, copper, brass, steel, and magnesium, as well as wood, leather, and glass. The adhesives also adhere well to a wide variety of plastics with the exception, as previously mentioned, polyethylene, Teflon, and polyvinyl alcohol. Reports on quantitative measurements of peel strength, and of structural strength on substrates other than those reported here will be made in the future.

Summary and Conclusions

Polyamides from polymerized vegetable oil acids and polyethylene polyamines have been used for years as heat-seal adhesives and cements. Recently, newly developed polyamides have been reacted with epoxy resins to form structural adhesives. These adhesives resemble conventional amine-cured epoxies, but have certain inherent advantages over them.

Polyamide/epoxy adhesives are extremely resistant to impact in the finished bond. They retain a high percentage of their original strength after being subjected to severe mechanical shock. They are easily handled, and do not exhibit the toxic effects of the amine curing agents used to convert epoxies.

Polyamide/epoxy adhesives are resistant to a variety of proprietary materials and solvents, and retain much of their original strength after extended immersion in these products. They have high strength retention at elevated temperatures. By increasing the polyamide content, adhesives of good peel strength may be obtained.

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—THE END

Vinyls in the Packaging Field
(Continued from page 24)

into many interesting shapes and designs, and may be polished to crystal clarity, printed, or laminated to paper as a protective envelope. Probably the most important application of rigid vinyl sheet in packaging is in single-service containers. These containers are presently being filled with jams, jellies, and marmalades, and will soon be used for mustard, ketchup, relish, and other condiments. The containers are presently supplied to restaurants, hotels, and diners; but future possibilities point to hospitals, air and rail services, schools, and for home use in lunch boxes and picnic baskets. In fact, the potentialities of such packages in the food industry are enormous.

Heavy equipment and machinery are being protected by the armed services with envelope-type shrouds of vinyl sheets, or strippable spray coats. Shrouds designed especially for rapid removal are used to cover ordance equipment in permanent defense installations.

Improvement in the production of vinyl films and coatings has been so marked that the packaging field is finding more and more ways to take advantage of the versatility of these new materials.

—THE END

Plastics in Aircraft Primary Structures

Reinforced plastics are used now only in aircraft primary structures having radar requirements, but their future potential is bright.

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Before exploring the possible use of plastic materials in primary structural applications in aircraft, it might be wise to present some of the problems a designer must face when engaged in military aircraft design.

Presented in the "Handbook of Instructions for Aircraft Designers," written by the Air Research and Development Command, are requirements and definitions for aircraft design, as well as the factors that determine the suitability of materials for use in aircraft structures. This Handbook gives the following general design considerations which must be accorded foremost attention by the designer if he is to produce the finest possible aircraft within the limitations of the science:

(1) Military suitability. The ability of the aircraft to perform the mission for which it was primarily designed.
(2) Tactical versatility. The ability of the aircraft to perform missions other than that for which it was primarily designed.
(3) Human factors. The relation of human capabilities and limitations (such as crew safety, comfort, and efficiency) to the unnatural environment of flight.
(4) Maintenance. The airplane must be practical and serviceable, requiring a minimum number of special tools and equipment.
(5) Production and procurability. The procurement of a technically superior aircraft that is low in cost and suitable for both early service in quantity and rapid increase in production during wartime with minimum drain on national economy.
(6) Environmental condition. The demands of military strategy make it mandatory that aircraft be operated under a wide variety of climatic and environmental conditions.
(7) Safety and dependability. This characteristic largely determines the efficiency of the aircraft as being suitable for sound military operation.
(8) Vulnerability capabilities. Resistance to combat damage must be considered in all structures in order to provide for safe return of the aircraft.

In another section of the Handbook can be found the factors which determine the suitability of a material for use in aircraft structures. These factors are as follows:

(1) Homogeneity. The physical and chemical properties must be consistent and reliable.
(2) Weight An optimum combination of minimum weight and maximum performance is needed.
(3) Availability. The raw materials must be available even during wartime.

Table 1. Comparative Properties of Aluminum and Polyester Laminate at Room Temperature.

	Tensile Strength, psi.		Compressive Strength, psi.		Ult. Shear Strength,	Bearing Strength, psi.		Modulus of Elasticity,
	Ult.	Yield	Ult.	Yield	psi.	Ult.	Yield	psi.
Aluminum (24ST4)	61,000	38,000	57,000	38,000	37,000	116,000	61,000	10,000,000
Polyester-181 Fabric Laminate:								
0° and 90° warp angles	35,000	23,000	30,000	20,000	10,000	35,000	28,000	2,400,000
45° warp angle	18,000	12,000	15,000	10,000	10,000	—	24,000	2,400,000

(4) Stability. The material must have resistance to corrosion, fungi, moisture, operational temperature extremes, direct sunlight, and other similar atmospheric phenomena, such as ozone and dust, without depending on protective coatings.

(5) Heat resistance. When heat is a factor, the material used should be stable at the operating temperature to avoid a loss in corrosion resistance and strength with time.

(6) Fire resistance. Anything that burns freely is undesirable for use as a structural material in aircraft.

(7) Ease of fabrication and repair. It is essential that strong and reliable repairs can be accomplished in the field. Materials that are easily fabricated usually are repairable with minimum time and equipment.

(8) Standardization. Materials, sizes, gages, and processes shall be standardized insofar as possible in order to minimize inventories and processing means. This is of particular importance for expediting field maintenance.

Still another section of the Handbook gives pertinent information regarding non-metallic materials, and says that approved non-metallic structural materials may be employed in primary and secondary aircraft structures in accordance with the following restrictions: non-metallic structural materials may be employed in primary aircraft structures provided that fabricators obtain prior approval of the Wright Air Development Center for each specific application by submitting a process specification detailing the contemplated fabricating techniques, and a qualification test program to substantiate the ability of the process controls and the production tooling to produce adequate structurally consistent components; and non-metallic structural materials may be employed in secondary aircraft structures without the foregoing restrictions.

To finalize our thinking before investigating the possibilities of using reinforced plastic materials, it is important to define primary and secondary structures. Primary structural parts are those which form an integral part of any assembly necessary for unrestricted flight or landing of the airplane, or for the successful completion of its mission. Examples of such primary parts are the wings, fuselage, nacelle, control surfaces, landing gear, and the primary flight controls.

In addition, any part whose failure would cause loss of the assembly or detachment of the equipment it supports is considered as being a primary structure. These parts include external doors and closures; structures resisting the internal pressure; supports of heavy equipment; all armament supports; seats occupied during take-offs and landings; and supports for anything which, if detached by a crash landing, would injure the occupants.

Secondary structural parts are all those which do not fall into either of these two classifications.

Strength Properties

Our first consideration concerning reinforced plastics should be the strength properties of this material. To see where this material might fit in the aircraft primary structure picture, it can be compared with the predominantly-used aircraft material, aluminum (see Table 1).

When designing with the aluminum material, it is customary to consider that the metal is worked to its yield point, which is approximately two-thirds the ultimate value. The same has been assumed for reinforced plastic, although it has no yield point per se. Working the reinforced plastic to two-thirds its ultimate seemed to be satisfactory on a fatigue basis, since the material can be worked successfully for the 3,000-6,000 cycles required on modern fighters. However, limited stress-rupture data indicate that perhaps the material can be worked only to approximately 50% of ultimate. The above two-thirds allowances, therefore, are not conservative.

Another method of comparison would be on an equal-weight basis with aluminum. This is done in Table 2,

Table 2. Relation of Polyester Laminate Properties of Aluminum on an Equal-Weight Basis (Laminate made with 181 Fabric).

Angle of Warp of Laminate	Ult. Tensile, psi.	Ult. Compressive Strength, psi.	Ult. Shear Strength, psi.	Ult. Bearing Strength, psi.	Modulus of Elasticity, psi.	
					Tensile	Flexural
0° and 90°	86%	81%	41%	69%	36%	81%
45°	44%	40%	41%	59%	36%	81%

Table 3. Relation of Modified Epoxy Laminate Properties to Aluminum on an Equal-Weight Basis.

Angle of Warp of Laminate	Ult. Tensile, psi.	Ult. Compressive Strength, psi.	Ult. Shear Strength, psi.	Ult. Bearing Strength, psi.	Modulus of Elasticity, psi. Tensile	Flexural
0° and 90°	100%	105%	60-70%*	71%	52%	100%
45°	50%	55%	60-70%*	59%	52%	100%

*Based on known increase in interlaminar bond strength of modified epoxy over polyester.

and it will be noticed that the plastic laminate still suffers large reductions in mechanical strength.

Admittedly, the values presented thus far are on a parallel fiber laminate basis. It is true that this extremely anisotropic condition can be remedied by systematically randomizing the individual layers of fabric, but it would be expensive and difficult to do this on a high-production basis, and hard to always know if it has been done. Since it is obvious that the laying-up of laminates in this fashion would considerably increase the material and fabricating costs, it is reasonable to design with the orthotropic allowables.

Only values for polyester resins have been presented so far. There are other resins, such as the modified epoxies, from which laminates can be made that will give higher strengths. However, all of these materials are more expensive and more difficult to use than the polyesters. Despite these objections, a tabulation of the properties of a modified epoxy laminate in relation to those of 24ST4 aluminum on an equal-weight basis at room temperature is shown in Table 3. In this table, ultimate shear strength percentages are based on known increase in interlaminar bond strength of modified epoxy over polyester.

As shown in Tables 2 and 3, the bearing strength of the plastic laminates is low. This problem can be solved in both polyesters and modified epoxies by the use of more fasteners. However, shear strength is another matter, and appears to be the limiting factor in both types of materials.

Shear Strength

Shear strength plays an important role in the design of military aircraft. For example, bending of a fuselage in flight will tend to cause the outside skins to deform; when they resist, they are doing so in shear. Comparing aluminum, which is isotropic, to reinforced plastics, which are orthotropic, it is apparent that shear is the dominating strength factor in the materials.

Figure 1 illustrates the properties of aluminum and a reinforced plastic laminate in shear versus compression and tension. It should be noted that the shear value for aluminum, in this case, is 60-65% of its tension and compression values. On the other hand, the shear strength of the plastic laminate represents 29-33% of its tension and compression values.

Taking a closer look at the plastic laminate (see Figure 2), the causes of its lower shear are obvious. First, the laminate is weaker at 45° to the warp and fill. Second, the laminate has low interlaminar bond strength. Finally, the compressive modulus is low and, consequently, the critical buckling stress is much lower.

Design Comparisons

We have compared aluminum and reinforced plastic as to general strength differences. Now, let us take several actual part configurations made of aluminum and substitute reinforced plastic material for them.

The first part we can consider is a portion of the fuselage skin from a highly-loaded military airplane. The configuration is a panel which is 0.051-inch thick, 10 inches long, 10 inches wide, and made of 24ST4 aluminum. Since it is a mold line skin and is highly stressed, the rivets which attach it to the frame structure underneath are 3/16-inch in diameter, and are flush-mounted on centers one inch apart. This type of rivet mounting requires dimpling of the panel. The part is subjected to combined loads of tension and compression which produce shear, and a direct air load which tends to cause canning.

In considering making this part out of reinforced plastic material, the first question is how thick must the

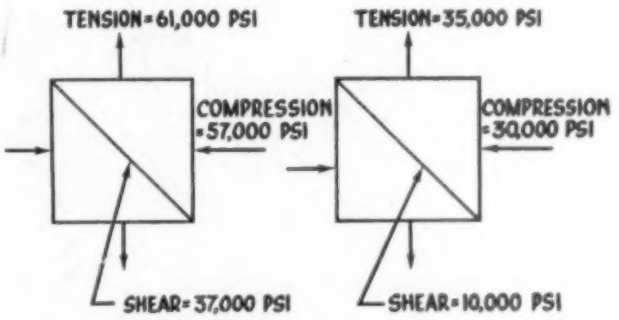


Fig. 1. Comparative shear, compression, and tension values for aluminum (left) and reinforced plastic laminate (right).

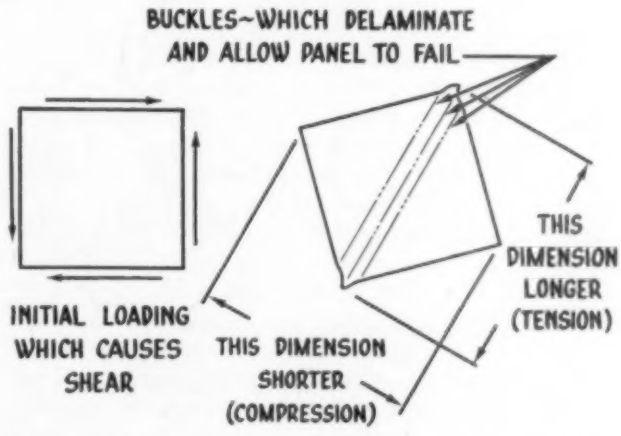

BUCKLES~WHICH DELAMINATE AND ALLOW PANEL TO FAIL
INITIAL LOADING WHICH CAUSES SHEAR
THIS DIMENSION SHORTER (COMPRESSION)
THIS DIMENSION LONGER (TENSION)

Fig. 2. Graphic representation of shear failure of plastic laminate by buckling.

Table 4. Comparative Cost per Part for Aluminum and Reinforced Plastics, Based on 500 Parts

	Reinforced Plastics			
	Bag molded, oven cured, phenolic tooling. Production time, 40 min./part using three tools	Bag molded, steam heated & water cooled tool. Production time, 25 min./part	Matched tooling, steam heated. Production time, 10 min./part	Aluminum
Tooling	$1.05	$0.45	$0.95	$0.90
Material	1.09	1.09	1.09	0.65
Fabrication	7.47	3.48	2.32	1.88
TOTAL	9.61	5.02	4.36	3.43

plastic be to resist canning. Analyzing the stiffness problem, we find the thickness would have to be 0.070-inch. Next, we calculate the thickness of plastic needed to resist the imposed shear loads, and find this thickness to be 0.110-inch. Since the panel must be attached by riveting, bearing resistance must be considered. By calculation, we find that the bearing resistance of the reinforced plastic will satisfactorily carry the load of 6,530 psi.

Summarizing, we find that a reinforced plastic panel measuring 0.110 by 10 by 10 inches will do the same job as a 24ST4 aluminum panel measuring 0.51 by 10 by 10 inches. But what about the weight? The aluminum panel weighs 0.51 pounds, while the plastic panel weighs 0.715 pounds. Cost is another factor; the aluminum costs approximately $0.80 per pound, while the reinforced plastic costs about $1.50 per pound. Considering all these facts, a material substitution does not appear likely.

Figure 3 shows another part, a hat section fuselage frame. Here, bending is the primary load consideration, with the maximum bending moment being 11,730 inch-pounds plus 2,350 pounds tension at the lower centerline of the part. When we attempt to substitute reinforced plastic for the aluminum material, the thickness increases 100% and the weight increases 30%. These changes result in a material cost of $8.93 per running foot of frame for the plastic part, as compared to $3.70 per running foot of frame for the aluminum part.

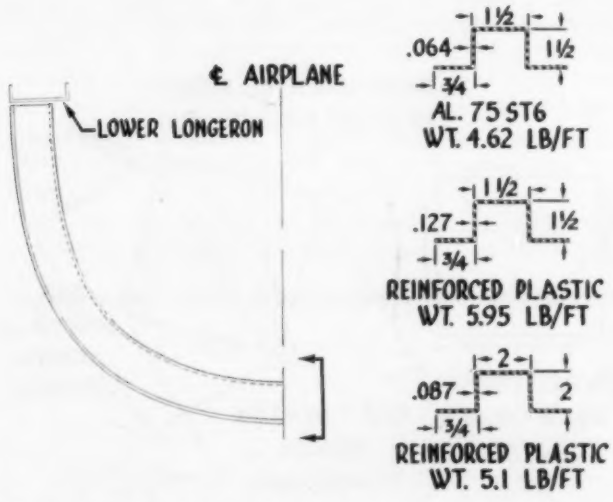


Fig. 3. Aircraft hat section fuselage frame, showing sizes of comparative sections made of aluminum and reinforced plastics.

Even if the configuration is changed to a more efficient design (assuming there is enough space clearance in the airplane to permit this change), the plastic will give a weight increase of 35% and a material cost of $7.65 per running foot of frame. However, none of the costs quoted above include fabrication. If they did, the differences over aluminum would be even greater.

Because of electrical necessity, wing tips (see Figure 4) often are made of reinforced plastic, regardless of cost and other factors. Where radio antennas are required in the wings, one wing tip is made of reinforced plastic. The other wing tip can be made either of metal or plastic, with the choice being based on over-all economy.

Table 4 gives a cost comparison per part for 500 parts when made of aluminum or reinforced plastics. From this table, it is evident that plastic part production normally must be extremely rapid to offer competition to aluminum. Actually, the part used for this tabulated data is being made of aluminum.

In all fairness, however, it should be noted that fabrication of aluminum parts also can be expensive. For example, when much welding is involved with an aluminum part, it is likely that a plastic part can be cheaper.

Current Status

To summarize the entire problem of using reinforced plastics in primary aircraft applications, we have found the following:

(1) The aircraft designer is obligated to consider many things in the application of materials. He must be certain that only optimum materials are used to insure the production of the finest possible aircraft within the limitations of the science.

(2) Polyester laminates compared with 24ST4 aluminum are 55-60% lower in ultimate tension, 55% lower in ultimate compression, 30% lower in shear strength, 25% lower in shear modulus, and about 35% lower in bearing strength.

(3) On an equal-weight basis, polyesters are 14% lower than 24ST4 aluminum in ultimate tension, 19% lower in ultimate compression, 59% lower in shear, 31% lower in bearing strength, and 19% lower in shear modulus.

(4) Comparing modified epoxies to aluminum on an equal-weight basis, we find their ultimate tension,

compression, and modulus to be equal, but the epoxies to be 35% lower in shear and 29% lower in bearing strength. The epoxies are more expensive than polyesters, and more difficult to use.

(5) The lower bearing strength of reinforced plastic laminates usually can be compensated for by adding more fasteners to carry the load.

(6) Shear is the prime consideration in substituting reinforced plastics for aluminum because the lower shear resistance of the plastic results in buckling and delamination.

Future Outlook

The picture presented thus far has not been too optimistic for reinforced plastics, but let us consider their outlook for use in primary structural applications. There are three major problem areas; strength, weight, and cost of materials and fabrication.

Strength properties of reinforced plastics will probably be on the increase in the very near future. New resins, new finishes on the reinforcing materials, and new reinforcements give preliminary indications of much higher strengths in all physical property values. Weight will take care of itself, simply by having higher strength properties. Obviously, the higher their strength-weight ratio, the more favorably reinforced plastics will compare with aluminum.

Cost of materials and fabrication poses the least optimistic picture for the future. If the new resins, new finishes, and new reinforcements improve the polyester and epoxy picture, their usage would still be advantageous only in bridging the temperature gap at which aluminum strengths drop significantly, and either steel, titanium, or high-temperature resistant plastics can take over. In this gap, fabrication costs would be outweighed by the necessity for lightweight temperature resistant materials.

Figure 5 gives strength-weight comparisons of reinforced plastics, titanium-manganese alloy steel, stainless steel, and aluminum. Comparing the phenolics on a high temperature basis with aluminum and steel, it is possible that the phenolics might be used in a limited range of 225-325° F. However, the strength-weight ratio of phenolics (only tension values are shown in Figure 5, the other properties being even less favorable) is only slightly higher than that of the titanium alloy or the 17-7PH stainless steel in this temperature range, so it is questionable whether these plastics would be used.

(Continued on page 34)

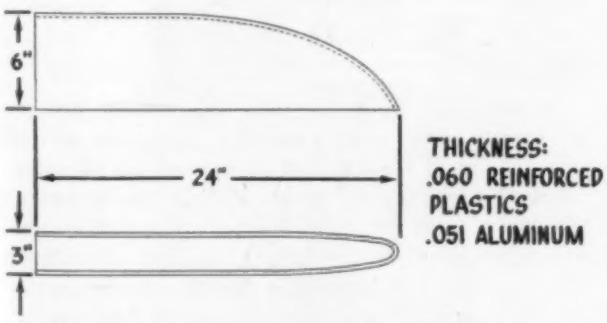


Fig. 4. Aircraft wing tip, showing comparative thicknesses in aluminum and reinforced plastics constructions.

Epoxy Adhesive Reduces Grinding Wheel Rejects

Epoxy adhesive being applied to outside of insert and inside of wheel at Sterling Grinding Wheel Co. to make bonded valve seat grinding wheels (right foreground).

Concentricity, important with any type of abrasive wheel, is an absolute must in the case of valve seat grinding wheels. The vitrified wheel must be bonded securely to an aluminum insert, be exactly on center, and be without the slightest warpage. This can be a problem, since the machined metal insert is very thin.

The Sterling Grinding Wheel Co., Tiffin, O., has found the choice of adhesive used to cement the wheel and insert to each other to be of major consequence. In the past, the company had used a resinoid cement formulation, but has found that superior results can be obtained with an adhesive based on Epon epoxy resin, a product of Shell Chemical Corp., New York, N. Y. The epoxy adhesive has a much higher bond strength, so that the wheel and insert will not separate even under heavy loads. In addition, the epoxy adhesive has eliminated the insert warpage problem encountered with the resinoid cement. This warpage necessitated excessive dressing of the wheel and, in some cases, rejection of the finished product.

The epoxy adhesive, supplied by Armstrong Products Co., Warsaw, Ind., comes in two components; the adhesive base and an activator. When mixed in the proper proportions, the adhesive has a pot life of about one-half hour. In production at Sterling, the adhesive is applied to the outside of the insert and the inside of the wheel (see accompanying illustration). An arbor press forces the two components together into a snug, concentric fit. The cemented assemblies, after being cured and then aged in a drying oven for two days, are dressed to size.

—The End

Visco-Mechanical Concept of Plastics Testing
(*Continued from page 21*)

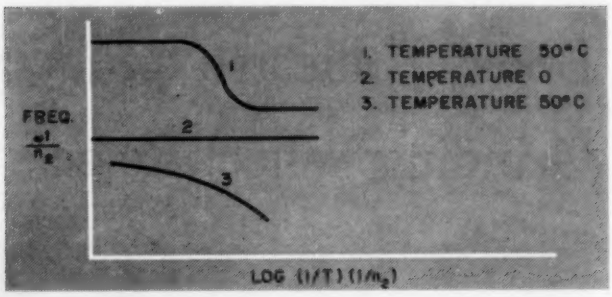


Fig. 10 Relationship of temperature and frequency on rubber as it changes from glassy state to rubbery state.

tant to know the reactions of these materials to temperature, humidity, and various types of vibration and other stresses.

As an example, physical tests can be used on a typical rubber to show quickly and, if properly designed, easily the behavior of the material over a wide condition change. If a plot is made of frequency versus the log of 1/T and the temperature is varied as shown in Figure 10, three curves will be obtained.

Curve 1 represents the change of the rubber molecule from the glassy to the rubbery state. Curve 2 represents the normal rubber state. Curve 3 represents the softening (flow) of the rubber molecule. Then n_2 expression is the internal viscosity of the molecule.

An examination of the curves in Figure 10 shows that there is a definite relationship between frequency and temperature; raising the temperature is equivalent to lowering the frequency, and vice versa. It can be seen from this data that where the behavior of rubber over a very wide frequency range is required, rather than employ very expensive and complicated equipment to provide the various frequencies it is only necessary to vary the temperature.

Conclusions

Some of the examples cited above indicate how the proper selection of test methods can not only drastically reduce the test time, but also provide the engineer with information on a given polymer that will tell him how it will react over a variety of stressing conditions. The goal of new testing methods, such as dynamic testing, is to advance evaluation techniques to the point where they can give a complete definition of strength properties in a minimum of testing time.

—THE END

Plastics in Aircraft Primary Structures
(*Continued from page 33*)

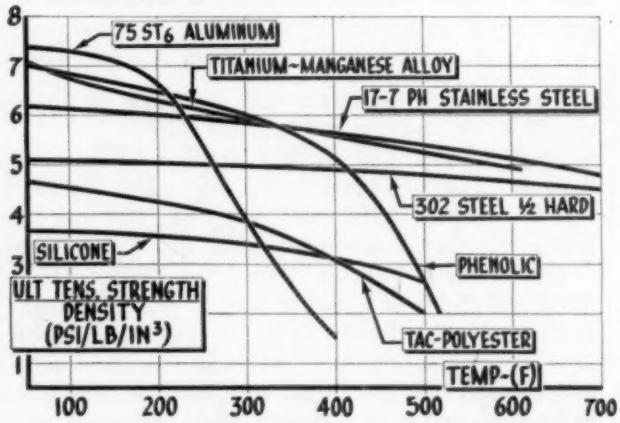


Fig. 5. Comparative strength-weight ratios for reinforced plastics, titanium alloy steel, stainless steel, and aluminum.

Undoubtedly, new developments in reinforced plastics will be forthcoming which may brighten this comparative picture. If better strength-weight ratios are realized over wider temperature ranges, the higher costs of reinforced plastics will be overshadowed by their weight advantages over steel materials.

Conclusions

This paper has been slanted toward the problems of primary structural applications in aircraft. The current picture for reinforced plastics looks gloomy, but the future has potentials. There are many applications where plastics are used now in aircraft primary structures, but this use is predicated on radar requirements, making cost and weight factors secondary.

Although their use in aircraft primary structures is quite limited, reinforced plastics have made tremendous inroads in less-critical strength applications. Parts in this category run the gamut from fuel tanks to electrical housing boxes, and from high temperature ducts to filler blocks. In these cases, both the designer and user are satisfied with the performance of plastics. The future should see reinforced plastics used in critical strength applications because of their strength properties alone.

—THE END

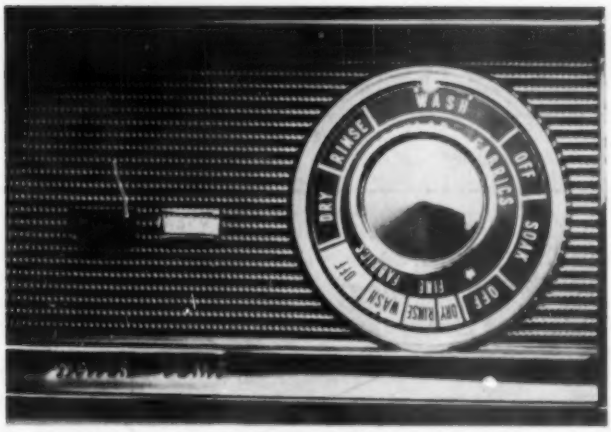
Rapid Screening of Plastisol Viscosity Depressants
(*Continued from page 23*)

With this second group, an extremely wide disparity in results was obtained. Thus, the glyceryl monoesters were found to be universally poor depressants; actually acting to increase plastisol viscosity. Conversely, it was discovered that polyethylene glycol 200 monoricinoleate imparted viscosity depressant properties superior to those of any commercial product evaluated when used in resins plasticized with either DOP or n-decyl octyl phthalate. Such extreme differences hardly were anticipated.

Conclusions

In summary, it is felt that this testing procedure provides a small-scale method for rapidly screening materials as to their ability to depress the viscosity of plastisol compositions. Data obtained in a series of tests have given results in line with practical industrial experience. As an important finding, polyethylene glycol 200 monoricinoleate is shown to be an outstanding viscosity depressant, possibly better than any other material recommended for this use to date.

—THE END



(1) Acrylic dial for washing machine shows even lighting, clear legibility of lettering ,and bright spot at top of dial, all obtained from one small light bulb.

Dial Utilizes Light-Transmittance of Acrylics

The attractive illuminated dial which controls cycling of the 1955 Easy automatic washing machine takes advantage of the light-transmitting characteristics of Plexiglas acrylic plastic, a product of Rohm & Haas Co., Philadelphia, Pa.

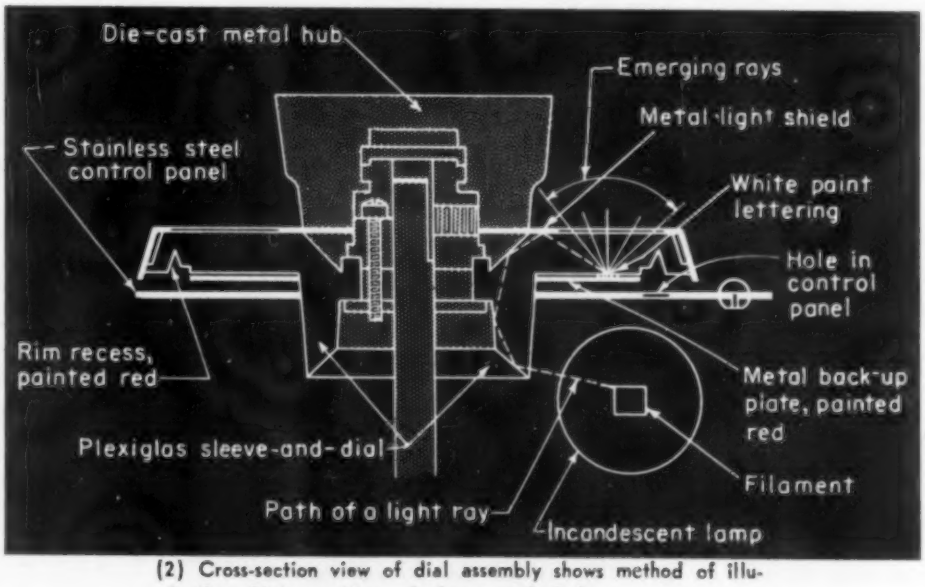
The dial is made up of a disc and a heavy sleeve molded in one piece of clear Plexiglas. Dial diameter is 3½ inches; the disc is 5/16-inch thick; and the sleeve, with a wall thickness of 3/16-inch, extends 9/16-inch behind the dial. The hub is die-cast metal, and the dial is backed up by a snug fitting, circular metal plate. A metal rim completes the assembly. The dial is molded by Erie Resistor Corp., Erie, Pa.

When installed on the stainless steel control panel of the washer, the dial is lighted by a small, concealed lamp. As shown in the diagram, light enters the sleeve through its outer wall, is reflected upward by a 45° bevelled edge, and is reflected radially throughout the entire dial face by another 45° bevel at the top surface of the dial.

The dial legend is painted in white on the interior or second surface of the clear molding. These painted letters interrupt the air-acrylic interface, causing the letters to reflect the light traveling through the dial face. As such, all control markings are illuminated simultaneously.

A dark red background for the dial is furnished by painting the metal plate behind it, thus preserving the air-acrylic interface and preventing the red background from absorbing the light. A small hole in the control panel above the lamp permits a spot of light to appear as a pointer on a grooved ring, painted red, which is molded into the outer edge of the dial.

—The End



(2) Cross-section view of dial assembly shows method of illumination. Note position of sleeve and dial.

News of the Societies

Plans for SPI Reinforced Plastics Division Meeting

The Reinforced Plastics Division of the Society of the Plastics Industry, Inc., will hold its annual Technical and Management Conference and eleventh annual exhibit on February 7-9 at the Chalfonte-Haddon Hall Hotel, Atlantic City, N. J. As in previous years, the meeting is open to members and non-members of the Society, subject to registration.

For the first time in its history, the Conference will include concurrent morning sessions on all three days, and concurrent evening sessions on the third day. This arrangement will permit the presentation of nearly 100 technical, engineering, and management papers at these sessions.

As in previous Conferences, the afternoons of the first two days will be contact periods in which the registrants can discuss their problems with industrial representatives. The afternoon of February 9 will be devoted to an open forum where technical and management questions will be answered by a panel of experts. This forum will be followed in the evening by the Division's annual banquet.

Newark Has Christmas Party

Nearly 300 members and guests of the SPE Newark Section attended the annual Christmas party on December 14 at the Military Park Hotel. The program included a dinner, floor show, and an evening of dancing. Table favors for the ladies were donated by Coty, Inc., and there was a drawing for the numerous door prizes available.

New officers and directors of the Section for 1956 were announced at a brief business session, as follows: president, D. A. Biklen, Orangeburg Mfg. Co.; vice president, R. H. Hoehn, Mack Molding Co.; secretary-treasurer, J. P. Lombardi, Shaw Insulator Co.; and directors, W. B. Bradbury, Plastic Molders Supply Co.; E. J. Csaszar, Eagle Tool & Machine Co., and D. J. Mullins, Dow Chemical Co. Outgoing president W. H. Willert, Frank W. Egan & Co., was presented with a wrist watch in token for his services to the group.

Rheology Society Meeting

The annual meeting of the Society of Rheology was held at the Henry Hudson Hotel, New York, N. Y., on November 2-4, with more than 120 members and guests attending. The meeting featured a technical program which consisted of five half-day sessions at which papers were presented on the rheology of metals, earth sciences, high polymers, and human health and disease, and the mathematical approach to rheology.

The high-polymers session dealt with developments in the study of the viscoelastic properties of the polymers. The use of stress-strain curves to characterize the properties of polyisobutylene was discussed, and a testing method for determining the dynamic mechanical properties of plastics was presented with data on the behavior of polymethyl methacrylate. A method of determining the dynamic bulk modulus was described, and the similarity between the behavior of melts and polymer solutions was demonstrated with data on molten polyethylene.

Other highlights of the meeting were the presentation of the Society's Bingham Medal to Dr. Herbert Leaderman, National Bureau of Standards, at a dinner on November 3; and the election of Society officers for the coming year, as follows: president, J. H. Dillon, Textile Research Institute; first vice president, J. H. Elliot, Hercules Powder Co.; second vice president, Bryce Maxwell, Princeton University; and secretary-treasurer, W. R. Willets, Titanium Pigments Corp.

SPI Sheet Forming Div. Set Up

A Sheet Forming Division of the Society of the Plastics Industry, Inc., to represent the interests of sheet formers and fabricators, sheet manufacturers, raw material suppliers, and machinery and equipment manufacturers was formally organized by members of this branch of the plastics industry at a conference and exhibit in Cleveland, O., on November 29.

J. S. Kivett, Regal Plastics Co., presided at the business session and introduced the speakers. W. T. Cruse, SPI executive vice president, gave a brief summary of the Society's divisions and their activities, and cited the benefits derived from the establishment of voluntary industry specifications and standards. Objectives of the new Division's committee were described by J. W. Knight, Fabri-Form Co., representing the sheet fabricators; E. F. Bachner, Jr., Campco Div. of Chicago Molded Products Corp., representing the sheet manufacturers and raw material suppliers; and S. S. Zimmerman, Vacuum Forming Corp., representing the machinery manufacturers.

Messrs. Knight and Kivett were elected Division chairman and vice chairman, respectively, by the 230 industry members attending the meeting.

Speakers at the one-day session were Hiram McCann, "Modern Plastics," who discussed "New Markets and Potentialities in the Sheet Forming Industry," and George S. Laaff, Bolta Products Div. of General Tire & Rubber Co., who spoke on "A Survey of Sheet Forming Materials."

Plastics in Home Decoration

The SPE Toledo Section held their annual Ladies' Night on November 22 at the Hillcrest Hotel. Some 56 members and their wives enjoyed the dinner and program which opened with door prizes and a drawing for a mink scarf.

Speaker of the evening was William Connolly, Bakelite Co., who discussed "Plastics Used in Home Decoration," and described types of floor tile, wall tile, wall coverings, luminous ceilings and other lighting applications, and special decorative effects achieved with plastics. The speaker used color slides to illustrate the talk, then astounded the audience with a series of magic tricks.

New Officers for Milwaukee

New officers of the SPE Milwaukee Section for 1956 were announced at a regular meeting on December 13 at the Bavarian Club. The officers are: president, C. E. Egan, Owens-Corning Fiberglas Corp.; vice president, M. C. Stowe, Stowe Plastic Products; secretary, Ken Charter, A. O. Smith Corp.; treasurer, John Canning, Cutler-Hammer, Inc.; and national director, Eugene Slingluff, Sunlite Plastics, Inc. New directors added to the Section's board were A. P. Anderson, A. O. Smith Corp.; W. P. Gobeille, American Motors Corp.; and John Verburg, Continental Can Co., Inc.

Speaker of the evening was J. L. Cross, A. O. Smith Corp., who discussed "Human Relations as a Means of Increasing Manufacturing Efficiency."

Predicts PVA Paint Demand

"Sales of PVA paints will hit close to the 50-million gallon mark by 1960," according to A. William Dunning, director of marketing for Shawinigan Resins Corp., Springfield, Mass., a major supplier of PVA emulsions for the paint industry. This prediction was made at the opening of the 20th annual Paint Industries Show, October 3, in New York City.

"PVA paint was introduced only five years ago," he continued, "and consumption has already approached 10-million gallons due to better products and increased consumer acceptance. PVA paints are particularly suitable for the do-it-yourself market since they are quick-drying, odorless, washable, and are easily-applied. These factors plus competitive pricing add up to an optimistic forecast for the future."

Record 1955 Sales Noted at SPI Film & Sheeting Conference

An optimistic attitude was evident at the sixth conference of the Film, Sheeting, and Coated Fabrics Division, The Society of the Plastics Industry, Inc., held on December 6 and 7 at the Commodore Hotel, New York, N. Y. The consensus of opinion among the approximately 500 registrants was that the industry had the best year in its history in 1955. Vinyl sales for 1955 showed a 20% increase, and most observers saw a strong connection between this increase and the promotional efforts on the vinyl film standard of quality. The outlook for 1956 is for a rapidly expanding market for the industry.

The opening session on the morning of December 6 was presided over by Robert Monica, Dow Chemical Co. Four papers were presented at this session, as follows:

"Automation in Handling and Proportioning Bulk Materials," I. H. Richardson, Richardson Scale Co. After describing the equipment available for mechanical handling and automatic weighing of bulk materials, the speaker emphasized that the equipment is well adapted for automation and the further application of instrumentation using monitoring systems.

"A Discussion of Fish-Eyes and Plasticizer Absorption," Marion R. Rector, Dow Chemical Co. Fish-eyes result when individual particles differ primarily in flow viscosity under the conditions of fabrication. These viscosity differences can be caused by cross-linking, variation in concentration of plasticizing materials, molecular weight, and compositional contamination.

"Laminates of Vinyls to Rigid Materials," Willard de Camp Crater, Naugatuck Chemical Div., United States Rubber Co. The Marvibond process of laminating rigid and semi-rigid vinyl sheeting to metal sheeting was described, and typical applications of the process were discussed.

"Converting Machinery for Processing of Plastic Materials in Web-Fed Operations," George L. Booth, Dilts Div., Black-Clawson Co., Inc. Four types of coating methods were discussed; knife coating, reverse roll coating, extrusion, and calendering. Roll coaters described were the reverse roll, pan-fed three-roll reverse roll, and nip-fed three-roll reverse roll coaters. Knife coating equipment discussed in detail included the knife-over-roll, unsupported knife, blanket-knife, and upside-down knife coaters.

The afternoon luncheon session, presided over by J. R. Price, Bakelite Co., consisted of an address by L. A. Hoegh, Governor of the State of Iowa; a paper, "Improvement in Vinyl Film Products," presented by Ephraim Freedman, R. H. Macy & Co.; an accomplishment report on vinyl standards seal of quality program; and the showing of a color motion picture on vinyl film products. In his talk, Mr. Freedman noted the progress made by the industry during the past two years, and emphasized the need for maintaining product quality and consumer acceptance, increased use of informative labeling, and education of consumers and retailers.

The morning session on December 7, presided over by Charles Edelmann, Firestone Plastics Co., saw the following five papers presented:

"Gage Control in Calendering," Michael Jakich, Goodyear Aircraft Corp. Stock profiles can be controlled by the application of a suitable crown to the rolls, the use of a good temperature control system, the use of a cross-axis arrangement on the gaging rolls, and the use of a beta-ray thickness gage.

"Valley Printing," G. F. Goldstein, Interchemical Corp. The equipment, materials, and operations for valley printing were described. The process consists of embossing vinyl film, sheeting, or coated fabric, and simultaneously coloring the areas which have been embossed.

"Present-Day Techniques in Heat Sealing," I. H. Schwartz, Radio Receptor Co. A discussion of current methods for electronically welding vinyl items.

"Vinyl Foam and its Applications," Reuben Wisotzky, L. E. Carpenter & Co. After a brief review of current development activities in the field of vinyl foam, the speaker discussed the characteristics of the foam, its effect on product design and application, and the current application techniques for the foam.

"Non-Structural Application of Vinyl Film and Sheeting," E. A. Haddad, Monsanto Chemical Co. Applications discussed included vapor barriers, vinyl-faced fiberglass insulating batting, light diffusion panels, corrugated ceilings, and vinyl-surfaced hardwood panels.

The afternoon session was presided over by Fred Strauss, Harte & Co., Inc., and consisted of a luncheon, followed by an address by J. C. Penney, J. C. Penney Co., and a talk on "Sales Training Techniques" by W. H. Grove, also of J. C. Penney.

SPI Reinforced Plastics Meeting

The Reinforced Plastics Division of the Society of the Plastics Industry, Inc., will hold its eleventh annual technical and management conference on February 7-9 at the Chalfonte-Haddon Hall Hotel, Atlantic City, N. J. The conference will feature concurrent sessions at which nearly 100 engineering, technical, and management papers will be presented. The sessions will deal with strength-time behavior of reinforced plastics; industrial designing; marketing and management; tooling; developments in processing, premix materials, and equipment; cost and safety; transportation; and others. A. W. Levenhagen, Molded Fiber Glass Tray Co., is in charge of the program.

As in the past, the meeting will also be highlighted by an exhibit of successful reinforced plastics applications. Open to all molders, laminators, and fabricators, the exhibits are designed to show the public and the plastics industry what is being done and what can be done with reinforced plastics.

Holds Plastic Tooling Forum

Approximately 50 members and guests attended the November 30 meeting of the Reinforced Plastics Group of SPE's New York Section, which was held at Tufaro's Restaurant, Corona, N. Y. The technical discussion following dinner featured a symposium on "Plastic Tooling," which was moderated by Robert J. Brinkema, R. J. Brinkema Co.

Malcolm Reilly, "Materials & Methods," spoke on the background and development of plastics tooling. Plastics can provide outstanding advantages when used properly, such as ease of machining, ease of duplication, cost, weight, and resistance to corrosion. Experimentation must be done to determine the extent to which plastic tools are feasible, keeping in mind their high temperature limitations and durability.

George Flett, Rezolin, Inc., discussed his firm's line of custom tooling compounds and allied materials. He described the technical services offered, covering in detail some special tooling problems and how they were solved.

The range of applications for plastics tooling was indicated by Benjamin Sokol, Republic Aviation Corp., who pointed out the advantages of such tools as aluminum-filled epoxies. Typical plastic tools used in aircraft plants include form dies, assembly fixtures, jigs, spinning forms, hydropress forms, welding fixtures, production samples, tooling forms, and tracing forms.

Principal applications for plastic tooling, as brought out by Walter Brenner, East Coast Aeronautics, Inc., are the manufacture of prototypes and small scale production of selected parts. Choice of a specific material is usually dictated by part requirements and the materials available to date include phenolics, polyesters, epoxies, and gypsum cements.

Larry Whitman, Whitman Co., brought out the fact that plastics tooling should not have a replacement connotation, but should be considered as an entity in itself.

A. I. Ch. Medal to Stevens

Raymond Stevens, senior vice president of Arthur D. Little, Inc., Cambridge, Mass., has been chosen to receive the 1956 Gold Medal of the American Institute of Chemists. The award is being made in recognition of Mr. Stevens' "contributions to a wider understanding of essential procedures for the management and operation of industrial research." Presentation of the Medal will be made to Mr. Stevens during the annual meeting of the Institute on May 9-11, 1956 at the Hotel Statler, Boston, Mass.

A graduate of Massachusetts Institute of Technology, Mr. Stevens served with the Chemical Warfare Service during World War I, and joined Little in 1920 as assistant to the late Dr. Arthur D. Little. In 1939, he was director of the Survey of Research in Industry for the National Research Council. During World War II, he was chairman of the Committee on War Use of Research Facilities, and became chairman of the Advisory Board on Quartermaster Research and Development in 1955.

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Holds Christmas Dinner-Dance

The SPE Southern Section held its second annual Christmas dinner-dance on December 19 at the Red Fez Club, Atlanta, Ga. The program included a steak dinner, an entertainment program, and an evening of dancing.

The new Section officers for 1956 were announced, as follows: president, C. V. LeCraw, Lockheed Aircraft Corp.; vice president, J. C. Beene, III, Plastic Industries, Inc.; secretary, R. W. Kruse, Rohm & Haas Co.; and treasurer, H. F. Loring, Gladwin Plastics, Inc. The three new additions to the board of directors are T. H. Hart, Hart Engineering & Sales Co.; and Messrs. Beene and Loring.

Dugliss Talks on Premixes

The importance of know-how in the formulation of premix compounds for reinforced plastics molding was stressed by Charles H. Dugliss, American Cyanamid Co., in a talk before SPE's Western New England Section on November 6. Sixty members and guests attended the meeting, which was held at Bradley Field, Windsor Locks, Conn.

Premixes, as defined by Mr. Dugliss have a filler present in a discontinuous state and have all their ingredients blended in prior to molding. Basic types include: compounds prepared by the molder using a mixing process; compounds prepared by the molder using a continuous process; proprietary compounds of the mixer process type; and proprietary compounds of the continuous process type. Each offers distinct advantages, and ultimate choice depends upon the part to be molded and end-use requirements.

Resin choice is broad, he added, advising the selection of one having a low viscosity-temperature index in order to attain uniform distribution of the reinforcing filler in the molded piece. In discussing filler types, Mr. Dugliss listed such materials as glass fibers, asbestos, sisal, ramie, chopped nylon, canvas, and synthetic fibers, as well as the non-reinforcing fillers.

Fast-closing presses should be used to minimize pre-gellation, except in cases of very low-viscosity compounds. Pressures of 50-500 psi. are used in compression molding, and choice of mold material depends on the number of parts to be produced.

Quebec R & P Group Reports

Seventy-eight members and guests attended the October 20 meeting of the Quebec Rubber & Plastics Group, which was held at Queens Hotel, Montreal, Que. Dr. A. J. Kirshner delivered a talk on "Effective Reading As an Aid to Better Communication," a subject which should be of considerable interest to the technical man who often must "translate" cumbersome scientific writings.

By selective reading (judicious extraction), the reader is able to derive the problem and the solution which he is seeking, without being subjected to a mass of extraneous detail. This principle of "structuring" is considered fundamental to rapid comprehension in reading. Dr. Kirshner illustrated his thesis with slides and illustrative technical articles.

Discusses Vacuum Metallizing

"Development of Vacuum Metallizing in the Plastics Industry," was reviewed by J. Gordon Seiter, F. J. Stokes Machine Co., in a talk delivered at the joint meeting of SPE's Philadelphia Section and the local SPI Chapter. September 27 was the date, and the meetng was held, as usual, at Franklin Institute in Philadelphia, Pa.

Metallizing depends on the ability of synthetic resins and lacquers to form a protective film. Basic designs of equipment for carrying out the baking, lacquer coating, and metallizing were described and illustrated by a series of slides. Information on capital investment, floor space, and operating cost was conveyed, together with technical advice on details of the process.

Mr. Seiter noted that progress has been made towards developing faster pumps and larger chambers, as well as new techniques for metallizing continuous strips and plasticized films. A number of products were shown, one a vacuum metallized doorknob which reportedly outlasts conventional brass-plated knobs.

Southern Section Meetings

SPE's Southern Section toured the injection molding facilities of Scripto, Inc., Atlanta, Ga., on October 17. The firm reputedly has the largest injection molding operation in the South, and offered an interesting example of mass production techniques.

On November 21, the Section was addressed by Clarence White, Eastman Chemical Products, Inc., on the subject of "Cellulosics in Molding and Extrusion." Outstanding properties and limitations of the four cellulose plastics were emphasized, along with the importance of close cooperation between the material supplier, the molder, and the end-user.

Precautions which should be observed by the molder were presented as follows: keep molding material dry; ensure optimum cylinder temperature; control the feed rate; use high injection pressure; and maintain good mold design. A color film, "The Story of Tenite," was shown following the talk.

NEWS of the INDUSTRY

Plastics Production and Sales Records Set in 1955

More plastics were produced before the end of the first 10 months of 1955 than in any previous full year, according to George C. Miller, president of Bakelite Co., New York, N. Y., in a year-end summary of the plastics industry. Plastic sales during this period also exceeded those of any other previous year, Mr. Miller said, and the production and sales rates established in 1955 are expected to continue through 1956.

Before the end of October, industry production of plastics surpassed the previous record output for a full year, set in 1953. Estimated production for October also set a new record for a single month's output. At least seven of the first 10 months of 1955 exceeded a monthly production rate of 300-million pounds of plastics; a monthly level never before achieved. Production of plastics in the United States should reach 3½-billion pounds in 1955, and sales are expected to total 3.3-billion pounds by the end of the year, Mr. Miller stated.

Estimates for total sales during 1955 show that all vinyl plastics posted a new high of about 600-million pounds, nearly 16.5% higher than the 1954 total. Sales of phenolic plastics in 1955 are estimated at about 450-million pounds, almost 15% above the 1954 figure. An estimated 545-million pounds of styrene plastics sold in 1955 marked an increase of more than 18% over 1954. Polyethylene sales in 1955 are expected to reach 350-400 million pounds, a gain of 40-50% over the previous year. Industry capacity for polyethylene by the end of 1956 is expected to exceed 600-million pounds annually.

Expanded applications of plastics which contributed to the 1955 records were given by Mr. Miller as including hard-surfaced vinyl floor coverings; laminations of vinyl film and sheeting with textiles; plastics components in electrical appliances; packaging applications; paints and coatings; styrene component parts in refrigeration; polyethylene pipe for farm water supply; polyethylene housewares; and automobile industry uses for various plastics.

New Chemical Highs in 1955

Chemical industry sales for 1955 will reach an estimated $23-billion, a new record high and 17.6% over 1954 sales of $19.5-billion, according to the Manufacturing Chemists' Association, Inc., Washington, D. C. Total investment in plant expansion for 1955 is expected to exceed $1-billion for the fifth consecutive year. Production for the chemical industry, like sales, reached a new high in 1955.

It is estimated that the chemical and allied products industries will pay $1.4-billion in federal taxes alone during 1955. The chemical industry supplied direct employment to more than 810,000 men and women, including more than 540,000 production workers. The industry rates as America's fourth largest industry, and has the second lowest industrial labor turnover rate.

The chemical industry continues among the safest in America. On-the-job accident frequency for the first nine months of 1955 was at the rate of 3.27 per million man-hours worked, matching the all-time low established for the year of 1954. Off-the-job accident statistics for the first six months, reported for the first time by MCA, show an average frequency rate of 6.26 per million man-hours worked, proving that a chemical industry employee is safer on the job than he is off the job.

Reichhold to Buy Plant Site

Negotiations are in progress for the purchase of Reichhold Chemicals, Inc., White Plains, N. Y., of a 30-acre plant site near Tacoma, Wash. On this site will be built a dry adhesives processing plant and warehouse, a greatly enlarged pentachlorophenol and muriatic acid plant, and modern control laboratories. This plant will be the thirteenth for Reichhold in the United States, and the second in the northwest Pacific area. Construction of the plant will be suverpised by H. O. Warner, Seattle plant manager. The Tacoma area was selected because of its ample power, water, and shipping facilities, and its proximity to raw materials and markets.

Opens Cellophane Warehouse

The first warehouse on the West Coast specifically designed for the storage and handling of cellophane has been opened by the film division, American Viscose Corp., Philadelphia, Pa. Located in Los Angeles, Calif., the new warehouse has a floor area of 30,000 square feet, and is equipped with the latest in slitting and sheeting machinery. The building is completely insulated, air-conditioned, and humidified to keep cellophane in prime condition.

The film division's West Coast district sales office, under the management of M. G. O'Connor, has been moved to the new building. However, the new operation will in no way affect the division's existing arrangement with Blake, Moffitt & Towne, who will continue as the only sales agent for Avisco film on the West Coast.

SPI 1955 Production Figures, and Estimates for 1956

The United States plastics industry reached a new peak in 1955 with the production of approximately 3.6-billion pounds of raw material, a 30% increase over the 1954 output of 2,827,803 pounds, according to the Society of the Plastics Industry, Inc., New York, N. Y. Consistent with the industry's growth, which has increased its volume of production by over 400% in the decade since World War II, the value of plastics products at the consumer level amounted to $1.8-billion in 1955, as compared with $1.4-billion in 1954. The 5,000-6,000 domestic companies connected with the plastics industry are now estimated to have reached an employment level of 175,000 persons.

Plastics raw material production in 1956 is expected to reach a new record of 4-billion pounds (2-million tons), the SPI predicts.

Varying increases in production were noted by the different plastics raw materials in 1955, as follows: phenolic molding materials, up about 16%; cellulosic molding materials, up about 21%; vinyl molding materials, up about 26%; polystyrene molding materials, up about 30%; and polyethylene, up about 50%. Polyester resin usage in reinforced plastics increased approximately 80% to an estimated level of 49-million pounds, and other reinforced plastics resins showed satisfactory increases. Vinyl film, by resin content only, is estimated to have reached a sales level of 85-million pounds in 1955, a 20% increase over the preceding year.

Business is good or excellent, according to 219 out of 221 plastics companies which answered an SPI questionnaire. This survey indicated that 208 of the 221 firms anticipate business during the first half of 1956 to be as good or better than 1955; 194 firms expect profits to be the same or higher; 201 expect their work force to remain the same or increase; 153 think that prices will remain the same; 182 reported collections to be good; 167 said their working capital was adequate; and 148 firms plan to expand. The survey indicated that the industry expansion would range from 10-15% in 1956, and be led by the injection molders and reinforced plastics companies.

Sets Up Polythene Laboratory

Over $135,000 worth of equipment is being moved into the York paint plant of Canadian Industries, Ltd., Toronto, Ont., to set up a temporary polyethylene technical service laboratory. All equipment will be of commercial size, enabling plastics engineers to recreate manufacturing conditions. Extruders, injection molding machines, a film-blowing unit, and a wire covering apparatus are included.

C-I-L recently completed a plant in Edmonton, for the manufacture of polyethylene from Alberta natural gas. Facilities at the laboratory will be devoted to technical assistance and to the comparison of alternative processing techniques to insure proper customer recommendations.

To Build Styrofoam Plants

Plans for the immediate construction of two new plants for the production of Styrofoam polystyrene plastic foam have been announced by Dow Chemical Co., Midland, Mich. One plant will be located near Ironton, O., and be known as the Hanging Rock plant, while the other unit will be the Riverside plant at Riverside, Mo. Completion of both units is scheduled for the fall of 1956, and plans call for about 100,000 square feet of floor space in each plant. Representing a sizable expansion move, the new plants will provide additional manufacturing facilities, supplementing units now in operation at Midland and Allyn's Point, Conn., and a third under construction at Torrance, Calif.

Cyanamid to Buy Formica

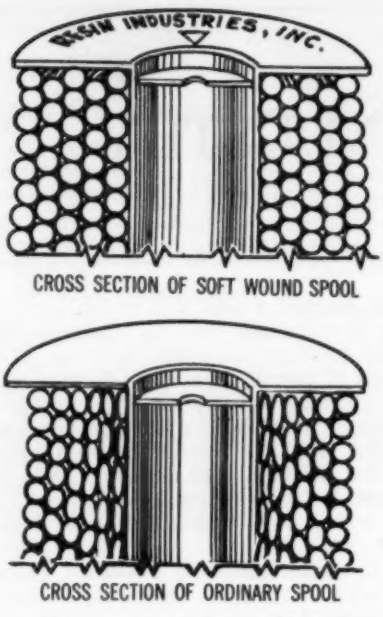
Negotiations are in progress whereby American Cyanamid Co., New York, N. Y., will acquire the business and assets of the Formica Co., Cincinnati, O. The proposed acquisition, detailed terms of which are still under negotiation, contemplates that Formica stockholders will receive 1¾ shares of Cyanamid stock for each share of Formica stock outstanding. When the acquisition takes place, it is planned to have Formica continue to operate under its present management as an additional unit in the Cyanamid organization. Final agreement will be subject to the approval of Cyanamid's directors and Formica's directors and stockholders.

The merging of the two organizations is expected to provide Cyanamid with national distribution channels to the consuming public and, at the same time, contribute significantly to the expansion of the Formica product line. Plans have already been developed by Formica for a $2½-million expansion program of its Evendale, O., plant to increase sheet laminating facilities by 20%. Construction of these facilities is planned to begin this spring.

Cyanamid, one of the pioneers in the development of thermosetting plastics in this country, has for many years devoted a large share of its research program to the field of plastics. The company is expanding its facilities in New Orleans, La., and Wallingford, Conn., to enter the field of thermoplastic resins.

Lurie Markets Plastic Sheets

Plastic sheets, for use by the vacuum forming, packaging, display, and allied industries, are being marketed by Lurie Plastics, Inc., Colonial Heights, Va. Two types of sheets are available: Luraplast HS, a high-impact styrene; and Luraplast P, a fine surface-finish polyethylene sheet made in gages from 0.015-0.125 inch and widths to 48 inches. The styrene sheet has a new three-dimensional gold or silver effect which is being accepted enthusiastically by the refrigeration, picture frame, and display fields.



Cross-sectional drawings of Soft-Wound and conventional spools show flattening of coils is eliminated by new method.

New Spooling of Vinyl Sleeving

A new method of spooling vinyl insulation sleeving, which eliminates the flattening of tubing coils close to the spool core of conventional spooling methods, has been developed by Resin Industries, Inc., Santa Barbara, Calif. This flattening causes thermal changes in the sleeving, and spool winding that is too tight, and occurs chiefly on spools of soft, thin-wall sleeving.

Called Soft-Wound, the new method provides for full-round tubing, even at the spool core; winding at normal tension; and spools having the normal firm compactness. Many types and sizes of Resinite tubing are being wound by the new method, and the balance of the company's production is being converted as quickly as possible.

Vinyl Foam for Novelty Items

Bolta Vinyl Foam is being produced in a variety of items for the novelty trade by Bolta Products, Division of General Tire & Rubber Co., Lawrence, Mass. Made under license from the Elastomer Chemical Corp., the foam is of interconnecting cell structure which allows the material to breathe; is highly resistant to acids, alkalies, oils, greases, soaps, and miscellaneous chemicals; is available in any desired color; and does not oxidize or change color upon aging or service.

The foam is easy to fabricate and, having a high degree of stitch-tear resistance, can be sewn readily or heat-sealed to almost any fabric. When heat-sealed to Boltaflex vinyl sheeting, it produces a quilted material having unlimited practical and decorative possibilities. An extremely smooth skin on one side of the material permits screen printing. In thicknesses of 1-2½ inches, the foam provides a medium-soft cushioning material which has uniform compressibility, does not "fight back," and is self-extinguishing.

Loma Completes Expansion

Another phase in the $750,000 expansion program of Loma Plastics, Inc., Ft. Worth, Tex., has been completed with the addition of 2,000 square feet of office space and 25,000 square feet of warehouse area. The latter expansion more than doubles the company's warehouse capacity. Other plans are under way for future enlargements and developments throughout the entire plant to keep pace with Loma's accelerated production program.

Personnel appointments announced by L. H. Barnett, Loma president, were: Milton Hamill, production manager; R. E. Partridge, plant manager; Mitchell Vuksonovich, plant molding superintendent; and Paul Gunn, coordinating engineer.

Koppers Purchases Durethene

Koppers Co., Inc., Pittsburgh, Pa., has purchased 80% of the common stock of Durethene Corp., makers of polyethylene film and tubing. Under terms of the agreement with C. A. Raabe, president and sole owner of Durethene, Koppers has purchased the controlling interest in the firm on a straight cash deal. Durethene will be operated as a partially-owned subsidiary of Koppers, with Mr. Raabe continuing as the chief operating executive. General supervision of the company will be under Koppers' chemical division.

Durethene occupies two plants in Chicago, Ill., and Los Angeles, Calif., and a large modern plant is being built in Chicago, to be completed in April. The acquisition of Durethene enhances Koppers' position in the polyethylene field.

New Polyethylene Plant

Plans for a joint venture to construct and operate a Ziegler-type polyethylene plant on the Pacific Coast were announced by the chemical division, Koppers Co., Inc., and Brea Chemicals, Inc., a subsidiary of Union Oil Co. of California. Process designs for the multi-million dollar plant, which will have a annual capacity of 50-million pounds, are being prepared by Koppers, while a joint engineering team is resolving the details concerned with plant location and operation. The new plant is scheduled for completion in 1957.

Opens West Coast Branch

A combined warehouse-office has been opened in San Francisco, Calif., by Cadillac Plastic & Chemical Co., Detroit, Mich. The facility, the second to be opened on the West Coast, is managed by Ted Harrigan. The warehouse will carry a complete stock of thermoplastic sheets, rods, and tubes, and will offer 24-hour service on all orders, and over-night truck delivery to points within 200 miles.

Dow to Guarantee Styron Tile

A program of guaranteeing Styron wall tile has been instituted by Dow Chemical Co., Midland, Mich., as part of an over-all program to upgrade the plastic tile industry. This move was motivated primarily by the difficulty in distinguishing between substandard products and those conforming to the voluntarily-adopted standards of 1950.

The program involves the issuance of an emblem to all certified dealers, along with a form guaranteeing a quality product, mastic, and installation. Other wall tile manufacturers have been contacted, and many are using it as a basis for their mechandising and advertising programs. The program has met with over 75% success to date, and both wholesalers and retailers are evidencing interest.

A directive has been requested from the Federal Housing Administration which would require certification of the tile product and the mastic, as to standards conformance, before being acceptable for FHA financing. Dow's proposed guarantee includes the following specifications: the tile must conform to National Bureau of Standards CS168-50; space for the dealer to sign that the mastic also conforms; and space for the dealer to certify that his installation procedure conforms to standards.

Eligibility rules for tile manufacturers are listed as follows: tile must conform to NBS 168-50; manufacturer must have adequate complaint handling procedure; the product must be guaranteed against defects in materials and workmanship, including color matches; tiles must be made of "mill-colored" materials, not dry blended; and the major portion must be Styron.

New Process Made Available

A process for producing super-refined benzene, toluene, and xylene from light oil is being made available for the first time in this country by Koppers Co., Inc., Pittsburgh, Pa. These three chemicals are used in the manufacture of many consumer items, including plastic housewares and toys, nylon stockings, synthetic detergents, paints, aniline dyes, and insecticides. Rights to the process were acquired by Koppers from the German firm which developed the method and has had it in commercial operation for several years.

According to W. C. Rueckel, vice president and general manager of Koppers' engineering and construction division, the process permits the production of more highly purified end-products than can be obtained with the conventional acid-wash method. Use of the process reduces the thiophene content and permits ready removal of paraffins. Equipment for the process is easily installed, Dr. Rueckel said.

Architect's sketch of new Perry Plastics plant.

New Plant for Perry Plastics

The new 40,000-square foot plant building of Perry Plastics, Inc., in Erie, Pa., is rapidly nearing completion, and is expected to be occupied by the end of January. Said to be one of the most modern and completely equipped molding plants in the country, the new building is a one-story structure that exemplifies the use of plastics in building. In addition to moving equipment from their old plant in Erie, the company has several new molding machines on order. Perry, established in 1946, has approximately 200 employees and operates 24 molding machines producing injection, compression, and fiberglass-reinforced molded products. Molded parts and assemblies are made for the refrigeration, automotive, and electrical industries, as well as on government orders.

Lunn to Make Swimming Pools

After completing several years of extensive tests of a reinforced plastic swimming pool, Lunn Laminates, Inc., Huntington Station, N. Y., has announced plans to enter the swimming pool market. Made of fiberglass-reinforced polyester, the small sample pool withstood all kinds of outdoor weathering conditions, including several hurricanes. According to J. C. Bohlen, industrial sales director for Lunn, the company has completed successful tests for durability, weather resistance, chemical resistance, color fastness, and other factors, and will start the manufacture of swimming pools in the very near future.

Du Pont Plans Hypalon Plant

The first full-scale plant for the manufacture of Hypalon synthetic rubber will be built by E. I. du Pont de Nemours & Co., in Beaumont, Texas. A chlorosulfonated polyethylene, the material has been available in limited quantities for market development and trade evaluation purposes.

Reported characteristics of Hypalon are its color, stability, and resistance to heat, chemicals, and oxidizing agents. Applications have included white sidewall tires, wire coverings, chemical tank linings, hose, belting, and protective coatings.

The new unit is scheduled for completion early in 1957, and will consist of two manufacturing facilities and a single-story warehouse. Additions and alterations to the power and service facilities at the existing Beaumont (methionine) Works will be made. Approximately 70 men will be required to operate the new plant.

Farrel Buys Press Line

Farrel-Birmingham Co., Inc., Ansonia, Conn., has purchased the business of the press division of the Watson-Stillman Co. division of H. K. Porter Co., Inc., Roselle, N. J. Consummated on November 2, the purchase included engineering and sales divisions, patents, drawings, jigs and fixtures for all W-S presses, but did not include any portion of the plant at Roselle, where W-S will continue the manufacture of other products.

By this purchase, Farrel-Birmingham rounds out its lines of processing machinery with the addition of presses of proven design and reputation. F-B plans to continue this engineering and sales activity at Roselle. The manufacture of presses at Roselle will continue until December 30, then be transferred to F-B plants. Farrel operates extensive manufacturing facilities in four plants at Ansonia and Derby, Conn., and Buffalo and Rochester, N. Y.

Prodex to Occupy New Plant

Prodex Corp., Fords, N. J., manufacturers of extrusion and process machinery, will move during the first quarter of this year into a new plant on a seven-acre site. The company, which formerly operated within the framework of Industrial Synthetics Corp. and Supplex Corp., both of Garwood, N. J., assumed completely independent operations when these companies became part of American Hard Rubber Co.

President of Prodex is Albert A. Kaufman, the former president of Supplex and Industrial Synthetics, and a member of the Editorial Advisory Board of PLASTICS TECHNOLOGY. The vice president is Arthur F. Scarpa, for many years secretary-treasurer and production manager of Hartig Engine & Machine Co. Prodex is currently making extruders in sizes from 2½-8 inches, as well as pull-off and other accessory equipment.

Titanium Dioxide Output to Rise

Plans for increased production of titanium dioxide, a white pigment widely used in plastics, paint, paper, and other products, have been announced by E. I. du Pont de Nemours & Co., Wilmington, Del. The company's Edge Moor, Del., and Baltimore, Md., plants will be expanded to produce additional quantities of the pigment, currently in short supply. These two projects, coupled with a previously-announced expansion at Edge Moor, will increase Du Pont's production of the pigment by more than 25%.

The first of the new facilities at Edge Moor should be completed this autumn, and the second Edge Moor expansion and the Baltimore project are scheduled for completion in 1957. In addition, the company is conducting engineering studies on a new titanium dioxide plant near New Johnsonville, Tenn., aimed at initial production in 1958.

Borden Buys Two Firms

The capital stock of American Resinous Chemicals Corp., Peabody, Mass., and Reslac Chemicals, Inc., Chicago, Ill., has been purchased by the Borden Co., New York, N. Y. According to A. R. Marusi, Borden vice president in charge of chemical operations, the acquisitions were made to further diversify Borden's activity in thermoplastics. There will be no changes in management, operating procedures, or personnel of the two purchased firms.

American Resinous Chemicals and Reslac make a wide range of products for the resin and plastics fields, including synthetic resins for paints, varnishes, paper, textiles, metals, plastics, wood, and adhesives; organosols, plastisols, and polymer solutions for surface coatings; natural and synthetic latex compounds and tackifiers; and hot melts and protective coatings for industrial purposes.

"Pure" Hydrogen Peroxide Made

The commercial development of a nearly anhydrous hydrogen peroxide has been announced by Becco Chemical Division of Food Machinery & Chemical Corp., New York, N. Y. The achievement is said to have resulted from a new continuous fractional crystallization technique, now patented by the company.

Although Becco does not list any immediate applications for the virtually 100% H_2O_2, Max E. Bretschger, president of the firm, calls it "a milestone in the history of the hydrogen peroxide industry." Becco introduced a 90% hydrogen peroxide in 1946, which is now used in rocket propulsion. The 90% concentration was thought at that time to be the practical limit of the anhydrous material, Becco says.

According to the company, the new process depends upon a continuous fractional crystallization, such that a solid phase of progressively higher hydrogen peroxide content moves in one direction through the apparatus, while a liquid progressively poorer in peroxide moves in the opposite direction.

The process is said to be an ideal complement to fractional distillation, which is commercially practical only up to about 90%. The crystallization process is most effective when operated with 90% feed stock. The take-off concentrations can be regulated to some degree, the practical maximum concentration being above 99.6% H_2O_2.

One of the apparent advantages of the new product form is its economical production. A second is the almost complete rejection of impurities, resulting in a much lower impurity level than that allowed by ACS reagent specifications.

Optimum operation of the new fractional crystallization process is for more than 98% H_2O_2. The company will market the product as SP 100. U. S. Patent No. 2,724,640, issued November 22, 1955, to G. G. Crewson and J. R. Ryan, and assigned to Becco, has been granted to cover the fractional crystallization process.

Integrated Plant for Venetian Blind Tape

The first completely integrated plant for the production of venetian blind ladder tape has been announced by Russell Mfg. Co., Middletown, Conn. The new production unit is at the company's Bennettsville, S. C., plant, and is the result of modernization and the transfer of certain operations from other plants. All venetian blind tape operations, including warping, weaving, finishing, and packaging, now take place in Bennettsville, which features a completely air-conditioned weaving room.

Russell also announced a new and improved tape, Ruslon 555, which is woven of Firestone Plastic Co.'s Velon vinyl yarn designed specifically for venetian blind ladder tape. Designed to nest neatly, hang flat, and not stretch, the new tape is dust resistant, easily cleaned, and available in a wide range of decorator colors.

Du Pont Increases Education Grants in 1956

A fund of more than $900,000 for grants in 1956 to more than 100 universities and colleges in its annual program of aid to education has been announced by E. I. du Pont de Nemours & Co., Inc., Wilmington, Del. This grant is a substantial increase over the $800,000 in gifts made in 1955-56.

All of the increase and nearly half of the entire new program are for the improvement of teaching in colleges, universities, and high schools. According to Crawford H. Greenewalt, Du Pont president, the grants are intended to advance the teaching of science and mathematics, and the program is designed to encourage more young men and women to go into teaching.

The fund for aid to teaching totals $445,000, including $200,000 to aid undergraduate teaching in 50 privately-supported colleges. Of this latter amount, $125,000 is for advancing the teaching of chemistry. The company's program for the advanced training of high school teachers of science and mathematics is nearly doubled, with a total of $130,000 in grants being provided for fellowships for active and prospective teachers for summer sessions and the next academic year.

The company has expanded its grants for post-graduate teaching assistantships to $115,000, covering 30 grants. Under its longer standing plans, Du Pont is granting $270,000 to universities for fundamental research, and $190,000 for post-graduate fellowships in science and engineering.

As in the past, the awards are being made to selected colleges and universities who will administer the funds and decide on the recipients.

Expansion Program Completed

An extensive expansion program, centering around the manufacture of concentrated pigment dispersions and a complete line of dry colorants for thermoplastic molding compounds, has been completed by American Molding Powder & Chemical Corp., Brooklyn, N. Y. The concentrates will be marketed under the trade mark Master Color, while the dry colorants will be sold under the trade mark Kromaplast.

Master Color will be concerned primarily with the coloring of polyethylenes and vinyls, to meet industry demand for more uniformity of color and dispersion. Kromaplast is a dry colorant for general-purpose and high-impact polystyrene and polyethylene. The company now is in the position to custom-compound polyethylene and vinyl, using its own concentrated pigment dispersions. It will specialize as subcontractors to the prime producers of polyethylene and vinyl insofar as color compounding is involved.

Knobs Made by New Method

Improvements in technique and equipment have resulted in a 25% increase in the production of thick-section phenolic plastic knobs by Auburn Button Works, Inc., Auburn, N. Y. The knobs are produced automatically by synchronizing the preforming, preheating, and molding operations. This adaptation of automatic rotary presses and other specialized molding equipment gives savings in time and labor; savings which are passed on to the users of the high-quality knobs.

High-density knobs of superior finish are ready for use as they leave the molding press. Where needed, metal inserts may be molded in without retarding the continuous process. Knobs with internally molded threads also are produced automatically.

In Brief . . .

Princeton University, Princeton, N. J., has announced a program of fellowships for students enrolled in its graduate plastics course of study. Fellowships with stipends of from $1,500-$2,100, plus tuition and fees, are available, and opportunities for employment as half-time research assistants at $1,500 per academic year are available to students not on fellowships. The graduate course of study leads to M.S. degrees in engineering, and includes lecture and laboratory classes, and contact with industrial plastics plants. The instruction covers properties, evaluation, production, fabrication, design, and applications of materials, as well as the chemistry of plastics.

The Polymer Corp. of Pennsylvania, Reading, Pa., has appointed three new distributors to handle its full line of industrial non-metallics, including Polypenco nylon, Teflon, and other specialty plastic materials. The distributors are Bearings, Inc., to cover Ohio, Indiana, Pennsylvania, West Virginia, New Jersey, and Kentucky; Dixie Bearing Co., to cover the southeastern and southwestern states; and Delta Products Div. of Air Accessories, Inc., to cover northern Texas.

(Continued on page 64)

News from Abroad

Plastics Fair at Dusseldorf

Now that the Plastics 1955 Fair, held in Dusseldorf, Germany, from October 8-16, has closed, organizers, exhibitors and workers can look back with satisfaction on the unqualified success their excellent cooperation made of the undertaking. The intensive publicity campaign that preceded the show was calculated to rouse general curiosity, and was largely responsible for the attendance of more than 60,000 foreign visitors out of a total of 242,000 visitors. These foreign visitors came mainly from West European countries, the United States, and Latin America. The number of visitors from the United States was considered especially surprising.

The eight large halls of the exhibition had a total floor area of more than 30,000 square meters in which 346 exhibitors, including 102 in the international machinery section, displayed a great variety of materials, products, and machinery. Practically every important German manufacturer connected in some way with the plastics industry seemed to be represented.

Naturally, much that had been seen at the 1955 Hannover Fair and, to a more limited extent, at the last Achema, was again on view in Dusseldorf, but there were improvements and new developments. Ziegler polyethylenes and their applications were among the chief attractions, and the exhibits of Chemische Werke Huls, Farbwerke Hoechst, and Ruhrchemie A.G. drew crowds. Chemische Werke Huls is making the polyethylene in collaboration with Bergwerkgesellschaft Hibernia. Ruhrchemie, which specializes in the high molecular weight polyethylenes, showed piping, bottles, and sintered blocks of the material which can be milled to form machinery parts and fittings. Hoechst, with the softer types of polyethylene, showed extruded pipe and fittings, the former for conveying hot liquids. These concerns expect to be able to produce a total of about 20,000 tons annually in the next few years, and up to 80,000 tons by 1961.

Wacker-Chemie G.m.b.H. featured its various vinyl products. This company, which launched its special cold-vulcanizing silicone at the Hannover Fair, is now understood to be starting the production of a new fluorine plastic named Olovin. This is an acetic acid ester of cellulose with a high content of a fluorine-chlorine component. Olovin is said to be waterproof like nitrocellulose; to have the mechanical and electrical properties and the low combustibility of cellulose triacetate; and to have the extensibility and cold resistance of acetobutyrate. It is suitable for making films, foils, and shapes with high dimensional stability, and to be suitable for use in varnishes and impregnating materials.

Transchemie Frankfurt, G.m.b.H., showed new Markon and Crystic types of unsaturated polyester resins which it now produces for Germany under license from Scott Bader & Co., Ltd. In the last few years, Germany has made considerable progress in the production of hardening catalysts for polyester resin. Oxydo G.m.b.H. displayed a series of organic peroxide catalysts prepared in paste form by a new process which is said to yield very homogenous and stable products that are practically free of water.

Among the exhibits by plastics manufacturers were a good deal of polyethylene piping for conveying chemical liquids and cold water, and rigid PVC piping. There were interesting applications of the Vulkollans in linings for pumps and pipe where high abrasion resistance is required, gear and friction wheels, large high-pressure packings, bearings, and handles for miners' coal pick hammers. Soft Moltoprene foam was shown in mats, upholstery, and linings of garments, while rigid Moltoprene foam appeared as an insert between two thin sheets of aluminum alloy in the construction of railway coaches. Kalle & Co., A.G., again showed their Hostaphan film, based on glycol polyterephthalic acid ester supplied by Hoechst.

Visitors were struck by the finish and design of supported and unsupported PVC film for luggage, footwear, draperies, and upholstery.

Ornamin G.m.b.H., which operates under license from a Swiss firm, had on view a variety of decorated trays, plates for children, lettered or numbered switch panels for various kinds of instruments, and similar goods. The effects are obtained by the use of a special plastic carrying the decoration, inscription, or numbers. During the molding process, this film is indissolubly bonded to the surface to which it is applied. The decorations or inscriptions are said to be unaffected by mechanical or chemical action.

Among the machines that attracted a good deal of attention was that designed by Hans J. Zimmer Co. for the continuous production in one operation of tubing and profiles from glass fiber-reinforced polyester. The pipe is built up of three layers of glass rovings, of which the top and bottom layers are laid longitudinally and the middle is wrapped circumferentially. The first layer of rovings, after being run into an impregnation chamber containing catalyzed polyester resin, is drawn through a guide ring and longitudinally over a mandrel. The second layer is wound circumferentially around the first by means of a rotating system of spools. Finally, the third layer, also impregnated, is laid longitudinally over the second. The second layer is not treated with resin, but is impregnated by contact with the other layers. Excess resin is squeezed off by a special ring. The mandrel with the prepared rovings enters an induction-heated former rod where gelation and hardening take place, after which a take-off device draws the section of tube from the mandrel. Tubing of any length can be made by this process, and the system has been adapted to the production of profile rod.

Among the numerous extruders shown was the new twin screw, three-color machine by Harburger Eisen u. Bronzwerke A.G., for insulating telecommunication cable with a multi-colored spiral sheath in which the colors go all the way through the plastic.

There were several cutting and grinding machines on display, including recent models by Alpine A.G.: the Rotoplex cutter-granulator which handles plastic waste in any form, from the thinnest foil to the heaviest rejects; the Contraplex Stud mills for sieveless grinding of soft materials by beating; the Superflex cool air mills for temperature-sensitive plastics; and the recently-developed Mikroplex Spiral Air Separator which permits exact aerodynamic separation in a centrifugal field of granulations down to about two microns in size.

The firm of Hermann Bauermeister showed their Turbo mills, designed for soft to medium hard materials, in which vertical motion of air, created by a rotor moving rapidly in the open chambers formed by the wide heater arms, is utilized as the grinding power. The pieces of material crush and grind each other, thereby allowing high output with low power requirement, while wear on the mill is said to be reduced.

Several machines for treating plastic surfaces also deserve mention. The latest machines by Dornbusch & Co. are designed to achieve striking decorative effects by a combination of embossing and printing on foamed plastic, fabric, or plastic-backed lengths of plastic. Arno H. Wirth demonstrated machines producing decorative velvety or plush-like surfaces on plastics by electrostatic flocking with conductive fibers. The fibers assume absolutely vertical position on the surface which has first been spread with an adhesive in an ornamental pattern by means of a screen-printing stencil.

British Plastics Exports

British exports of plastic materials during August 1955 were 7,450 long tons, bringing the eight-month total for the year to 54,845 long tons, an increase of 7,000 long tons over the comparable 1954 period. At their present volume, 1955 exports of plastics should total more than 82,000 long tons, close to a 20% increase over 1954 levels.

British imports of plastic materials through August 1955 are 50% greater than those of 1954, with vinyl resins accounting for 45% of the total. Imports of polystyrene and other molding powders are also said to be considerably greater than in 1954.

NAMES in the NEWS

G. W. Larson

E. V. Michal

Joseph Grabowski

Art Nufer

Monsanto Chemical Co., plastics division, Springfield, Mass., has announced the following promotions in an organizational realignment at the Springfield plant:

Allen G. Erdman as general superintendent for manufacturing, responsible for production of PVC, Saflex polyvinyl butyral, Vuepak cellulose acetate, and Nitron cellulose nitrate.

Charles E. Knight as general superintendent for maintenance, plant engineering, transportation, and materials handling.

John E. Swan as general superintendent for staff services, to direct and coordinate non-manufacturing services.

Robert G. Carter as manufacturing superintendent for phenolics.

Willard P. Willis as manufacturing superintendent for polyvinyl chlorides.

R. Wolcott Hooker, vice president of Hooker Electrochemical Co., Niagara Falls, N. Y., was elected 1956 president of the Synthetic Organic Chemical Manufacturers Association. **John H. Hilldring,** president of General Aniline & Film Corp., succeeds **Mr. Hooker** as first vice president of the Association.

William G. Swalwell has joined the monomer department, chemical division of The Borden Co. in Los Angeles, Calif., as a technical representative. Formerly with Pacific Coast Borax Co. and North Coast Chemical & Soap Works, **Mr. Swalwell** will deal primarily with polyvinyl alcohol, acrylic rubbers, and Methac solvents.

John H. Leary has been named manager of the Middle Atlantic district for Hull Corp., Abington, Pa. Upon his discharge from the Army in 1946, after serving as an officer in the Chemical Warfare and Ordnance divisions, he returned to Drexel Institute of Technology and received a B.S. in chemical engineering in 1948. Previous to his new position, he was with F. J. Stokes Machine Co., rising to be manager of vacuum impregnating and drying equipment.

Floyd J. Gunn has been appointed manager of Dow Chemical Co.'s office in Los Angeles, Calif. Former manager of coating sales for the plastics department, he succeeds **Homer L. White** who joins the production control staff in Midland, Mich.

George A. Cypher has been appointed insulating materials specialist for General Electric Co.'s chemical materials department, and will be located at the alkyd resin plant in Schenectady, N. Y. **Dr. Cypher** formerly headed the materials development and applications groups at G-E's Thomson Laboratory, Lynn, Mass.

Henry H. Reichhold has resigned from the board of directors of Catalin Corp. of America, due to the fact that his firm, Reichhold Chemicals, Inc., was unable to arrive at a satisfactory basis of merger with Catalin.

Oliver E. Beutel has been advanced to the newly-created position of manager of distribution and traffic for Dow Chemical Co., Midland, Mich. In his new capacity, he will coordinate the distribution of Dow chemical from all divisions of the firm to markets both here and overseas. With Dow for 20 years, **Mr. Beutel** has served in various capacities, the most recent being traffic manager of the Texas division.

Olin D. Blessing

Olin D. Blessing, sales manager of Dow Corning Corp., has been named a vice president. He has served as general sales manager since the company was founded in 1943.

Eli Hartz has been named manager of the vacuum forming plant for St. Regis Paper Co.'s Panelyte division, Richmond, Ind. He formerly served as chief engineer for Panelyte's plant at St. Jean, Quebec.

Donald A. McQuarrie, plastics engineering student at Lowell Technological Institute, Lowell, Mass., has been awarded the first scholarship for plastics study established by the Society of Plastics Engineers, Inc. The check for $200 was presented by Harry Connors, president of SPE's Eastern New England Section.

American Cyanamid Co., New York, N. Y., has announced the following appointments in its plastics and resins division:

G. W. Larson as supervisor of plastics promotion.

E. V. Michal as supervisor of thermosetting products.

Joseph Grabowski as supervisor of thermoplastic products.

Art Nufer as senior technical sales representative for thermoplastic compounds.

E. L. Meadows has been appointed supervisor of marketing information services for Carbide & Carbon Chemicals Co., New York, N. Y. He joined the firm in 1927 as a laboratory assistant at Mellon Institute, was transferred to the general sales office in 1929, and was made district office manager in Newark, N. J., in 1950. In his new position, he will be responsible for organizing and expanding a marketing information center to service all marketing groups in the company.

Robert E. Wilkin has been elected to the board of directors of Hooker Electrochemical Co., Niagara Falls, N. Y., and named vice president and director of sales. After joining the company as sales manager of fine chemicals in 1939, he was successively named assistant sales manager in 1939, eastern sales manager in 1943, general sales manager in 1949, and vice president and general sales manager in 1953.

Paul E. Weber has been appointed sales manager for the chemical division of Charles Pfizer & Co., Inc., Brooklyn, N. Y., succeeding **Frank F. Black.** He has served as Western regional manager, national field sales manager, and as assistant sales manager at the Brooklyn headquarters.

Thomas G. Bishop

Thomas G. Bishop has been promoted to sales manager of the plastic machinery division, Hydraulic Press Mfg. Co., Mount Gilead, O. A graduate chemical engineer from the University of Cincinnati, **Mr. Bishop** served several years as assistant manager of H-P-M's Teaneck, N. J., eastern office.

Edmond S. Bauer has been appointed assistant director of sales for resin products, plastics division of Monsanto Chemical Co., Springfield, Mass. **Thomas W. Sears,** former assistant sales manager, replaces **Mr. Bauer** as sales manager of industrial resins.

Alfred Hirsch has been named to the newly created post of research scientist within the research organization of Diamond Alkali Co. A 27-year man with the company, **Dr. Hirsch** has served as senior group leader at the Diamond Research Center in Painesville, O., since 1954.

General Electric Co.'s phenolic products section, Pittsfield, Mass., has announed the following appointments: **James F. Whitney** as superintendent of the phenolic products plant; **Anthony G. Polidoro** as purchasing agent; **Boyette Edwards** as specialist, operations research projects; and **Kenneth L. Laut** as supervisor of manufacturing at the Coshocton, O., varnish plant.

Jules D. Lippmann, general manager of the Textileather division, General Tire & Rubber Co., Toledo, O., was presented with a scroll autographed by the firm's 700 employes. The honor was conferred at a service award dinner, and paid tribute to **Mr. Lippmann** as an outstanding "boss."

George E. Kopetz has been elected vice president in charge of production, Blaw-Knox Co., Pittsburgh, Pa. At the same time, four veteran employees were promoted: **Arne O. Olson,** vice president in charge of engineering; **Keator McCubbin,** vice president and manager of the chemical plants division's Midwest headquarters; **Charles F. Hauck,** vice president for sales; and **Edward S. Wright,** vice president in charge of construction.

Walter R. Roberts, for 20 years manager of silicate sales for Diamond Alkali Co., Cleveland, O., has retired. He is succeeded by **Clifford S. Hancock,** manager of calcium carbonate sales for the past seven years, who will continue in this capacity in addition to taking over responsibility for the sales of all Diamond silicate chemicals, except detergent silicates which will be handled by **C. W. Turner,** manager of detergent specialty sales.

The film division, American Viscose Corp., Philadelphia, Pa., has announced one addition and two transfers of personnel. **Howard P. Heilman** has been appointed a salesman in the Chicago, Ill., office, handling the sale of Avisco sheet and roll cellophane in Gary and Hammond, Ind., and south Chicago. **Thomas W. Trainer** has been moved from a technical service department post in Fredericksburg, Va., to the company's new warehouse in Los Angeles, Calif. **Richard E. Glenn,** formerly a salesman in Chicago, was shifted to cover the western and northern Michigan area.

J. Joseph Kelly

K. S. Mellkian

F. W. McIntyre, Jr.

J. Joseph Kelly, former general sales manager, has been promoted to vice president in charge of sales, Reed-Prentice Corp., Worcester, Mass. **Frederick W. McIntyre, Jr.,** has been advanced to vice president and works manager of the company, which is an affiliate of Package Machinery Co.

H. G. Robinson has been appointed works manager for Acheson Dispersed Pigments Co., Philadelphia, Pa. He has been acting as production manager, and will continue that function in addition to new duties. **E. L. Florence** has been named staff engineer, and **H. A. Acheson, Jr.,** becomes assistant to the general manager.

Charles A. Heiberger has been appointed manager of the plastics & polymers department, Central Research Laboratory, Chemical Divisions, Food Machinery & Chemical Corp., San Jose, Calif. **Dr. Heiberger** joined the company's Ohio-Apex Division, Nitro, W. Va., as research director after having been with United States Rubber Co. He is succeeded as Ohio-Apex's research director by **Paul E. Willard,** former assistant research director.

H. Seymour Colton

H. Seymour Colton has resigned as president of Colton Chemical Co., Cleveland, O., as of January 1, to become president of Macco Chemical Co., Wickliffe, O. Macco manufactures mastic, an adhesive used in attaching plastic tile. In his new position, **Mr. Colton** plans to enlarge manufacturing facilities at Macco, and to develop a complete line of new products. He will devote about two-third of his time to Macco, and be available for the remainder as a consultant in polymers and other forms of chemistry.

Hooker Electrochemical Co., Niagara Falls, N. Y., has announced the following personnel changes:

Philip D. Bosso as personnel director, Durez Plastics Division, No. Tonawanda, N. Y.

Alton V. Thorpe as personnel director, Niagara Falls plant.

Fred Olotka as technical foreman, fine chemicals, Niagara Falls plant.

Barrett B. Brown as department head, fine chemicals, Niagara Falls plant.

William F. Lynch as administrative assistant to vice president in charge of public relations.

Herman Harrow as personnel and office manager, Durez plant in Kenton, O.

Lee Cisneros has been named general traffic manager of Godfrey L. Cabot, Inc., Boston, Mass. Formerly associated with Cabot Carbon Co., Pampa, Tex., he was transferred to Boston as assistant traffic manager in 1950.

Carbide & Carbon Chemicals Co., New York, N. Y., has announced the following changes and additions within its sales organizations:

D. R. Beasley transferred from the Institute, W. Va., plant to fine chemicals sales and market development.

Mary Anna Bresnahan appointed to fine chemicals studies and market development.

Arvid Teleki as market researcher.

A. P. Chavent as technical service representative, Cincinnati district.

A. A. Douglas as technical service representative, Charlotte district.

W. P. Emerson as technical service representative, Atlanta district.

J. F. Flynn as technical service representative, Boston district.

J. T. Fox as technical service representative, New Orleans district.

R. F. Gildehaus, Jr., as technical service representative, Philadelphia district.

D. P. Shannon as technical service representative, Kansas City district.

B. H. Wilder as technical service representative, Detroit district.

R. W. Wittmus as technical service representative, Indianapolis district.

Charles Warner and **Cecil F. Backus** have retired as directors of Atlas Powder Co., Wilmington, Del. **Wilfred D. Gillen,** president of Bell Telephone Co. of Pennsylvania and the Diamond State Telephone Co., has been elected to the board of directors.

Lee Cisneros has been named general traffic manager of Godfrey L. Cabot, Inc., Boston, Mass. Formerly associated with Cabot Carbon Co., Pampa, Tex., he was transferred to Boston as assistant traffic manager in 1950.

Albert Goldstein and **James Mitchell** have joined the research and development staff of Catalin Corp. of America, New York, N. Y. **Dr. Goldstein** received his Ph.D. at Cornell University, and was previously associated with General Foods Corp. **Mr. Mitchell,** a graduate of College of the City of New York, comes to Catalin from Riley Tar & Chemical Co.

Walter W. Peacock, Jr.

Nat C. Robinson has been appointed director of research for Escambia Bay Chemical Corp., Shreveport, La. **Dr. Robinson** will have headquarters temporarily with the National Research Corp., Cambridge, Mass. **Walter W. Peacock, Jr.,** has been named sales manager for the firm's PVC division. Escambia Bay will erect a multi-million dollar plant at Pensacola, Fla., for the manufacture of plastic raw materials.

Philip A. Singleton has been appointed assistant to the president of Monsanto Chemical Co., and secretary for the firm's executive and finance committees. Former managing director of Monsanto Chemicals, Ltd. of England, he succeeds **J. P. Ekberg, Jr.,** who is returning to the organic chemicals division as manager of intermediate sales. **Herbert S. Parham** has been appointed to the newly created position of assistant director of sales for that division.

Robert H. Kilgore

Robert H. Kilgore has been appointed manager of General Tire & Rubber Co.'s newly-formed flooring division, with headquarters in Akron, O. He previously served as field sales manager for a major film and flooring manufacturer.

George R. Milne has been appointed president of National Carbide Co., division of Air Reduction Co., Inc., succeeding the late **J. Carl Bode. Russell T. Lund,** vice president, replaces **Mr. Milne as** vice president-operating. **Mr. Milne** will maintain headquarters in New York City, and **Mr. Lund** will remain at Calvert City, Ky.

Edward T. Butler has been appointed general sales manager of Acheson Dispersed Pigments Co., Philadelphia, Pa. Former sales manager of Diamond Alkali's plastics division, he has a background of many years experience in the plastics and protective coating industries.

Albert L. Shutts has been appointed sales manager, New York territory, for the Becco Chemical division, Food Machinery & Chemical Corp., Buffalo, N. Y. **Mr. Shutts'** territory covers parts of New Jersey, Massachusetts, and Connecticut as well as New York State

T. R. Miller has been appointed director of development for Carbide & Carbon Chemicals Co., New York, N. Y. He formerly served as director of plant laboratories in South Charleston, W. Va.

George A. Fowles, sales manager of plastic materials for B. F. Goodrich Chemical Co., Cleveland, O., has accepted an assignment with the U. S. Dept. of Commerce as director of its Chemical & Rubber Division, Business & Defense Services Administration. His duties with Goodrich will be handled by Robert E. Dettlebach while he is on loan to the Commerce Department. An M.I.T. graduate in 1934, Mr. Fowles served with Anaconda Wire & Cable Co. and Jackson & Moreland, and joined Goodrich's sales organization prior to World War II.

Morton B. Gilbert has been appointed a sales engineer in the Chicago district office of F. J. Stokes Machine Co., Philadelphia, Pa. Holder of a B.S. in chemistry from the University of Massachusetts, he has been with Central Scientific Co and Consolidated Vacuum Corp.

Charles H. Carpenter, Jr., has been named assistant manager of the market development department, and **Joseph P. Davis** as personnel assistant for Metal & Thermit Corp., New York, N. Y. **Mr. Carpenter,** a chemical engineer, was previously with American Cyanamid Co. and United States Steel Corp. **Mr. Davis** was formerly with Irving Trust Co. and Upsala College.

Waverly W. Moore has been appointed a sales representative for Reichhold Chemicals, Inc., covering the Southern states. **William T. Marshall** has joined the firm's sales office in New Orleans, La.

J. Warren Kinsman has retired as vice president and member of the executive committee of E. I. du Pont de Nemours & Co., Inc., due to health reasons. This action terminates 40 years of service spent in numerous management capacities.

S. L. Duff has been named sales representative for the pigments division of American Cyanamid Co., working out of the St. Louis, Mo., office. He previously served as assistant to the Eastern regional sales manager.

OBITUARY

Louis M. Timblin

Louis McFarland Timblin, treasurer and a director of Charles Pfizer & Co., Inc., Brooklyn, N. Y., died November 20 at Mather Memorial Hospital following a heart attack.

Born in Midway, Pa., in 1899, Mr. Timblin was graduated from Marietta College, Marietta, O. He joined Pfizer in 1940 as auditor and later became assistant treasurer. In 1945 he was appointed treasurer for the firm, and subsequently was elected director and member of the executive committee. Prior to his association with Pfizer, Mr. Timblin had been with F. W. Lafrentz & Co., certified public accountants.

Services were held November 22 at Campbell's Funeral Chapel, New York City, followed by interment at St. James Mehodist Cemetery, St. James, L. I., N. Y. Mr. Timblin is survived by his wife, Irene, and two sisters.

New Materials

Write item numbers on Readers' Service card to obtain more information.

Highly Transparent Polyester

A polyester resin, reportedly capable of producing fibrous glass-reinforced laminates with greater transparency than has been possible previously, has been introduced by Rohm & Haas Co. Suggested formulations combine this material, Paraplex P-444, with monomeric styrene or vinyl toluene to obtain refractive indices closely approaching that of glass.

The polyester was designed specifically to resist discoloration by ultraviolet light, erosion, and to mask the appearance of glass fibers. Chemically, the material is an unsaturated polyester containing monomeric methyl methacrylate which is blended with 10-25% of the aforementioned monomers to effect the desired properties along with rapid cure.

These blends can be cured at room or elevated temperatures, as can conventional polyesters. Pigments and/or dyes may be added to produce a colored polymer. The recommended blend is 80 parts of Paraplex P-444 to 20 parts of the other monomer; however, this ratio may be varied to suit individual operating conditions. For example, if the temperature of the resin is 86° F., and a viscosity of 300 cps. is required, then the blend should be 85:15.

Limited field experience has indicated that the material has a tendency to develop bubbles and voids. Should this occur, pot or flash degassing should be employed. Details on these procedures are available from Rohm & Haas' resinous products division. Physical properties of the liquid resin and of a cured, unfilled 80:20 blend are reported as follows:

Acid number	30-38
Viscosity, Brookfield @ 25°C., cps. as supplied	3,000-4,000
Blended but uncured, cps.	160-200
Specific gravity, uncured	1.115-1.183
Cured	1.23
Refractive index, uncured	1.4993-1.5105
Cured	1.546
Catalyzed stability @ 25°C., days	2.5
Flexural strength, ultimate, psi	17,400
Modulus of elasticity, psi	634,000
Tensile strength, ultimate, psi	10,000
Modulus of elasticity, psi	656,000
Elongation, %	2
Hardness, Rockwell M	110-115
Heat distortion, °C	80
Water absorption, 24 hrs. @ 25°C., %	0.25
At 100°C.	4
Volume shrinkage, %	9.3

Readers' Service Item M-1

Phenolic Molding Compounds

Two general-purpose, wood flour-filled phenolic molding compounds for both compression and transfer applications have been made available by Synvar Corp. Called Synvar PM-6449 and PM-6599, they are brown and black in color, respectively, and are said to be characterized by an extremely fast curing speed and excellent flow.

Synvar PM-6449 has a molded specific gravity of 1.41-1.43, according to the company, while that of PM-6599 is 1.33-1.35. All other physical specifications of the two compounds are equivalent, and some of these are as follows:

Molded shrinkage, in./in.	0.005-0.007
Heat distortion temperature, °F.	290 min.
Water absorption, %	0.5 max.
Tensile strength, psi.	6,500 min.
Flexural strength, psi.	9,000 min.
Compressive strength, psi.	30,000 min
Impact strength, Izod, ft.lbs.	0.26 min.
Dielectric constant @ 1,000 cycles	7.0 max.

Readers' Service Item M-2

Organo-Silicone Release Agents

A series of six organo-silicone compounds, said to possess outstanding lubrication and anti-wear properties, have been developed by Linde Air Products Co. Designated X-520, X-521, X-522, X-525, X-526, and X-527, these chemicals also have the release properties, water repellency, and special thermal and viscosity stability of the Linde silicone oils.

The latter three compounds duplicate the first three, respectively, but additionally contain 0.5% PANA oxidation inhibitor. X-520 and X-525 are moderately viscous fluids which are soluble in water; X-521 and X-526 are low melting point waxes which are also water soluble; and X-522 and X-527 are low viscosity fluids which are insoluble in water, but soluble in both high and low aromatic solvents.

Aqueous solutions should be approximately neutral, since high and low pHs hasten hydrolysis and separation. Both sodium nitrite and PANA buffer the solutions and prolong this stability. The materials should be stored in their original containers, being careful to protect against water contamination. Availability ranges from 1-55 gallons in drums. Properties are quoted as follows:

	X-520, X-525	X-521, X-526	X-522, X-527
Viscosity, cstks., @ 77°F	900	Solid	95
At 100°F	575	130	75
At 210°F	90	25	16
Pour point, °F	—34	95*	—56
Flash point, C.O.C., °F	505	440	410
Fire point, C.O.C., °F	510	515	445
Coefficient of expansion	7.8×10^{-4}	7.5×10^{-4}	7.5×10^{-4}
Surface tension, dynes/sq.cm.	19.1	19.8	21.6

* Melting point.

Readers' Service Item M-3

Epoxy Stabilizing Plasticizer

An epoxy-type stabilizing plasticizer, designed to stabilize nitrocellulose, ethylcellulose, butyrate, and PVC against heat and ultra-violet light, has been introduced in pilot-plant quantities by Baker Castor Oil Co. Called Estynox 308, the material differs from epoxidized oils by its marked solubility in alcohols, higher viscosity, and greater resistance to gasolines and aliphatic solvents.

Acetoxy groups, in addition to epoxy groups, add to the polarity of the product. Estynox 308 achieves peak stabilizing effect when used in conjunction with barium-cadmium laurate. This combination is said to be particularly effective in vinyl compounds containing phosphate plasticizers, which are normally difficult to stabilize.

Extremely low volatility and complete saturation assure retention of color and flexibility upon aging in nitrocellulose lacquers. Since it contributes only nominal plasticizing action in nitrocellulose, hard and tough films are obtained using up to 50 parts Estynox per 100 of nitrocellulose. The material reportedly can be used to replace part of the short to medium oil length non-drying alkyds with little loss in hardness.

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Following are some of the chemical and physical properties reported for Estynox 308:

Color, Gardner	1
Acid value	4
Specific gravity at 25° C.	1.015
Saponification value	292
Volatile content, %	0.2
Pour Point, °F.	0

Readers' Service Item M-4

Machinable Chlorinated Polymer

A chlorinated polymer, said to offer better dimensional stability than the nylon and fluorocarbon polymers currently available, has been introduced by the Polymer Corp. of Pennsylvania. Designated Polypenco K-51, the material does not exhibit the cold flow characteristic of fluorocarbons, and is resistant to internal strain.

Applications are seen in production equipment where corrosion is a problem. Tests have shown Polypenco K-51 to be satisfactory for gears, bearings, rollers, and similar exposed parts. High-cost instrument parts can be fabricated on automatic screw machines, yet the material is reported to be reasonably priced. Rods up to two inches in diameter are available, and strips, slabs, tubes, and larger-diameter rods will be marketed in the near future. Physical properties are as follows:

Impact strength, notched Izod, ft. lbs./in. notch	0.4
Unnotched, ft. lb/in. width	33
Hardness, Rockwell	100
Deformation under load, 2,000 psi. @ 122°F., %	1.4
Compressive stress a: 1% offset, psi	8,800
Compression modulus, lb./sq. in.	130,000
Heat distortion, 5x½x½-in. bar at 264 psi., °F	185
At 66 psi	300
Specific gravity	1.4
Tensile strength @ 73°F., psi	6,000
At 212°F	3,500
Tensile modulus @ 73°F., psi	160,000
At 212°F	90,000
Elongation @ 73°F., %	60-160
Flexural strength @ 73°F., psi	5,000
Flexural modulus @ 73°F., psi	127,000
Water absorption, %	0.01
Dielectric strength, volts/mil	400

Readers' Service Item M-5

VANSTAY

Vanderbilt Materials for Vinyls

VANSTAY C Provides efficient heat stabilization at low cost in tile formulations.

VANSTAY L Recommended for maximum light stability and improved natural ageing in all vinyl resin compositions.

VANSTAY HT–VANSTAY S This combination provides excellent heat protection for vinyl compositions during processing and in service.

VANSTAY N Recommended for use with Vanstay S in non-plating heat stabilizer systems.

VANCIDE 89 Non-metallic fungicide and bactericide effective in vegetable plasticized vinyls.

Our Technical Service Representatives will gladly demonstrate the merits of our materials in your plant and assist in solving production problems.

Color-Stabilizing Alkyd Resin

Improved color and gloss retention in white industrial baking enamels is reportedly obtained through the use of a new, non-oxidizing alkyd resin recently introduced by Rohm & Haas Co. Called Duraplex ND-76, the material also is said to impart hardness and mar resistance, as well as resistance to alkalies and household soaps.

Duraplex ND-76 is compatible with urea, melamine, triazine, and in most proportions with nitrocellulose, butyrate, and some silicone alkyds. Coatings may be reduced with xylol or toluol, and the addition of butyl alcohol is recommended for formulations high in melamine or urea content. Physical constants for the resin and properties for a finished formulation are reported as follows:

Solids content, %	59-61
Acid number	6-10
Weight, lbs./gal.	8.5
Color, Gardner	5
Solids at 60 sec., #4 Ford cup, %	64
At spray viscosity, %	56.5
Pencil hardness, 30 min. at 200° F.	2B
At 250° F.	H
At 300° F.	2H
Adhesion, Arco micro knife, 30 min. at 300° F.	10.4
Photovolt gloss, one coat	83.6
Gloss retention, two coats, 30 min. at 300° F.	75.8
At 400° F., 16 hours	54
Color retention, Photovolt comparator, 30 min. at 300° F.	6
At 400° F., 16 hours	13.9

Readers' Service Item M-6

New Equipment

Write item numbers on Readers' Service card to obtain more information.

Stokes Model 533 rotary tablet machine

High-Speed Rotary Tabletter

A 10-ton, high speed rotary tabletter capable of production ratings up to 2,500 per minute has been introduced by F. J. Stokes Machine Co. Designated Model 533, the machine comes in two versions: one with 33 stations, which can press tablets up to a maximum diameter of 1 1/16 inches and 1⅛ inches depth of fill at rates of 900-2,500 per minute; the other with 27 stations producing 700-2,000 tablets, 1 3/16 inches maximum diameter and 1⅜ inches in fill depth.

Used for plastic preforming, the press features hydraulic loading of the upper pressure roll, non-drop inserts in the lower pressure roll to prevent double impressions, anti-jump retainers on the lower cams, and individual die screws. A large diameter punch circle and wide roll faces reduce the load on bearing surfaces and punches, thus providing ample overload protection. An extremely low roll pressure rate of 36,000 pounds per inch of displacement affords greater protection for delicate tooling and longer life for moving parts.

Neckless punches are listed as standard equipment; and all controls, including direct-reading tachometers and pressure indicators, are grouped at the front of the press. All manual adjustments are made by handwheel from the operator's normal location. Automatic, gear-operated lubrication provides oil under pressure to all vital wear points.

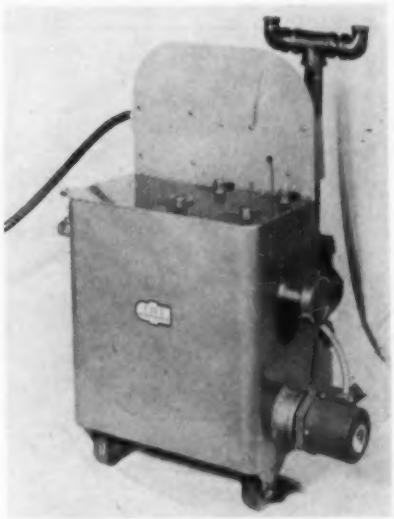
Other contributing features include: stainless steel hoppers; feed frames which permit transit-type leveling; multiple dust nozzles; vibration mounting; totally-enclosed variable-speed drive; heavy-duty clutch, bearings, and inserts; removable upper dwell cam; and upper and lower punch lubricators.

Readers' Service Item E-1

Mold-Temperature Circulator

A low-cost circulator for maintaining injection mold heats over a temperature range from 50-250° F. has been introduced by Injection Molders Supply Co. A redesigned unit, the instrument features a built-in thermometer which permits a rapid check of circulating medium temperature.

Equipped with casters and built-in cooling, the circulator sells for what is reportedly a fraction of the cost for similar type units. Design is by Majestic Molding Co.



IMS injection mold heat circulator

Readers' Service Item E-2

Toggle-Action Molding Press

A 50-ton semi-automatic press for compression and transfer molding has been introduced by F. J. Stokes Machine Co. Designated Model 731, the press features a toggle action, and is said to be particularly adapted for molding shallow parts such as resistors and capacitors.

A patented bar controller provides accurate control over set-up and cycle time and push-button calibrated adjustments. These buttons can be reset within seconds to meet new requirements, even while the press is in operation. By recording these settings, the cycle can easily be duplicated at a later date. A single electrical timer reportedly suffices.

Model 731 automatic toggle press

Automatic, three-stage closing action reduces closing time and generally speeds up the production cycle. High speed during ram approach is accomplished through a newly-designed regenerative oil circuit. Oil removed from the top of the ram and refed through the bottom gives double the normal approach speed. This speed is cut to approximately 25% at a predetermined point, where built-up mold pressure further slows the action to a final closing speed. Since the mold closes only as fast as the material plasticizes, molded parts are of high density and uniformity.

Following is a list of specifications quoted for the press:

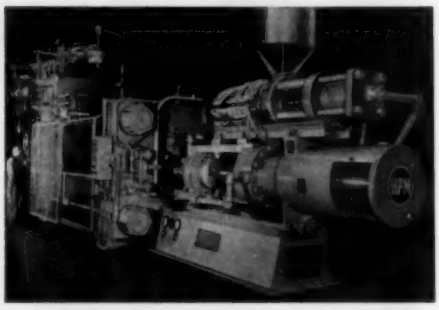
Die space, in.	20x16.5
Stroke, in.	7
Distance between platen is (press closed), in.	8-19
Ejector stroke, in.	2
Height, in.	82
Platen down, in.	43.5
Floor space reqd., in.: Press	34x19
Power unit	30x48
Weight, power unit & press, lbs.	5,500

Readers' Service Item E-3

Injection Molding Machine

What is reported to be the largest injection molding machine ever built has been announced by The Hydraulic Press Mfg. Co. Designated Model 3000-P-400, the unit develops 3,000 tons of clamp pressure in six seconds, and is said to complete a dry cycle within 22 seconds.

Capacity for the 363,000-pound machine is rated at 400 ounces. Other special features include a positive "shot" measuring device, a pre-plasticizing chamber which operates independently of the machine cycle, hydraulic ejectors, and a built-in hydraulic mold elevator.



Model 3000-P-400 injection molding machine.

Two models designed for the production of extremely large parts, such as refrigerator liners, are presently in use. Specifications are reported as follows:

Height, ft.	15.666
Length, ft.	43.666
Width, ft.	12
Material injected per cycle, cu. in.	706
Plasticizing capacity, lbs./hr.	600
Hopper capacity, lbs.	475
Mold clamp return, tons	200
Mold space, vert. x hor., in.	49 x 88
Clearance between tie rods, in.	50 x 50
Distance between platens, in.	108
With ram spacer, in.	84
Mold thickness, in.	48
With ram spacer, in.	24
Clamp travel, in.	60
Injection pressure, max., psi.	20,000
Plunger diameter, in.	7.125
Plunger stroke, in.	18
Heating chamber, kw.	138
Motor, hp.	355
Oil reservoir capacity, gal.	1,500

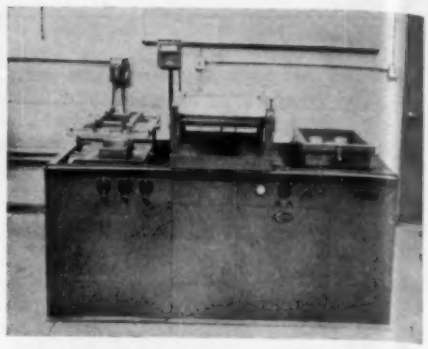
Readers' Service Item E-4

Two-Way Vacuum-Drape Former

A combination vacuum and drape forming machine with both male and female molds has been introduced by the Vacuum Forming Corp. Designated VacForm Model 88-FM, the machine features a self-contained unit which permits the operator to handle drape and vacuum forming runs simultaneously.

Durably constructed of welded steel, the unit is intended for developmental and experimental work, short production runs, and rapid manufacture of small-sized items. Specifications are quoted as follows:

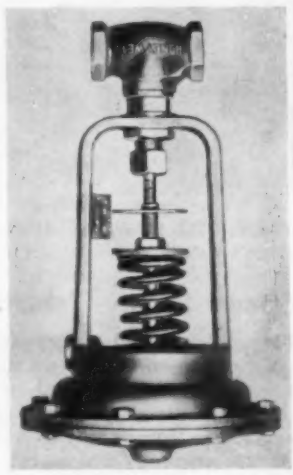
Floor space required, in.	28 x 90
Height, in.	54
Weight, lbs.	500
Mold size, in.: Min	2 x 2
Max.	16 x 16
Platen size, in.	18 x 18
Heater capacity, kw.	3.5
Heater size, in.	22 x 22



Model 88-FM vacuum and drape forming machine.

Depth of draw, in.	6
Vacuum pump, cfm.	3
Tank capacity, gal.	15

Readers' Service Item E-5



Series 400 Type 47 diaphragm control valve

Diaphragm Control Valves

A new line of diaphragm control valves designed for medium-duty applications has been introduced by Minneapolis-Honeywell Regulator Co. Designated Series 400, the valves are said to incorporate compact design with improved flow characteristics.

The Series includes three basic valve types: double-seated, single-seated, and three-way. The first mentioned valve, Type 47, is available in cast iron body sizes ranging from 1-6 inches. Type 48, a single-seated valve, ranges in size from ½-4 inches and is available both in cast iron and bronze. Type 49 three-way valve is cast iron, sizes ½-2 inches.

The valves can be used in either "on-off" or proportional systems. Neoprene diaphragms with cotton inserts permit operating temperatures up to 160° F. Nominal spring range of 3-15 pounds is standard and maximum working air pressures are established at 50 psi.

Readers' Service Item E-6

Substantial Savings in BERYLLIUM CASTINGS

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OMNI PRODUCTS CORP., Export Distributors, New York, N.Y.

New Products

Write item numbers on Readers' Service card to obtain more information.

Gram-Pac triple-laminate container for chemicals.

Laminated Disposable Packing

A disposable package for research grade chemicals in convenient unit weights has been introduced by Fisher Scientific Co. Called Gram-Pacs, the package consists of a triple laminate of polyethylene acetate, and aluminum foil.

The flat, factory-sealed packs contain carefully measured 10- and 25-gram amounts of reagent chemicals, thereby eliminating waste, reducing inventory, and cutting down on breakage of reagent bottles. Field tests have shown that even deliquescent, efflorescent, and photosensitive reagents have a long shelf life when packed in Gram-Pacs.

The tough inner film of Bakelite's polyethylene is said to resist abrasion and tearing by granular, hard, or bulky chemicals. Together, the laminated combination keeps out all impurities, as well as light, air, heat, and moisture. Nearly 200 chemicals for which the ACS has established purity specifications, as well as hygroscopic materials, will be available in Gram-Pac packages. Identification labels will contain lot analyses.

Packed 10 to a box and 12 boxes to a case, the new packaging makes possible contamination-free distribution to individual laboratories within a research organization. Even after the individual package has been torn open, re-folding the torn edge will provide an effective moisture barrier, according to the manufacturer.

Readers' Service Item P-1

Portable Boat Speedometer

A portable speedometer for measuring boat speeds and the like has been introduced by Betzel Specialty Mfg. Co. Called Speed-Wand, the instrument consists of a Tenite butyrate tube marked with a graduating scale which indicates speeds from 5-35 miles per hour.

Operation is reportedly simple. The smaller end, which has an inlet opening, is submerged and pointed in the direction of boat travel. Removed vertically, the speed is read directly from the level of the water meniscus along the calibrated scale. A bronze check ball closes the inlet when the speedometer is held in this position. Afterwards, the water can be drained through a hole in the cap of the tube.

The Tenite material is marketed by Eastman Chemical Products, Inc. Molded parts are supplied by Libbert Tool & Die Co., and extruded parts by Southwestern Plastic Pipe Co. Speed-Wand can be used in either fresh or salt water, and is said to be especially helpful in selecting the proper outboard motor angle for maximum speed.

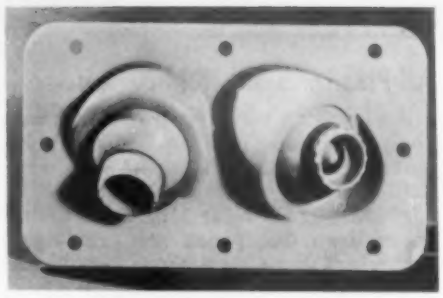
Tenite butyrate boat speedometer.

Readers' Service Item P-2

Lightweight Melamine Valves

Plaskon melamine molding compound, a product of Barrett Division, Allied Chemical & Dye Corp., is being used by Wemac Co. for adjustable air valves in the Lockheed Super Constellation, Martin 404, Douglas DC-6 and DC-7, Lockheed 1049, and the Lockheed 749. Light weight and range of color are but two of the reasons responsible for the material's growing popularity, it was reported.

The valve currently used on the Douglas DC-7 weighs only 1.8 ounces, and is warm to the touch due to melamine's low thermal conductivity. Undesirable water condensation is avoided with the material, and a wide range of color combinations permit freedom of design. Some valves are used as hot air vents which must withstand temperatures up to 170° F., yet components can be held to very close dimensions. Air valves using melamine components were given a life test of 100,000 cycles and continued to function properly.



Adjustable air valves of Plaskon melamine.

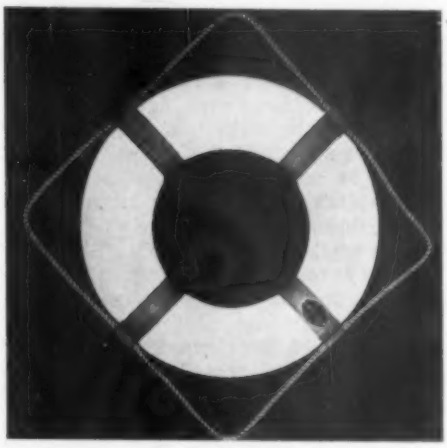
Readers' Service Item P-3

Vinyl Foam Life Preserver

A lightweight ring lifebuoy molded from one piece of cellular Geon vinyl plastic has been approved by the U.S. Coast Guard for both passenger and private craft. The Spongex ring, produced by B. F. Goodrich Sponge Products Division, eliminates conventional covering and therefore requires no maintenance.

Composed of millions of tiny air chambers, the foamed material is said to offer lifetime buoyancy. Unaffected by punctures or gashes, the smooth outer surface of the ring makes it impervious to sun, salt water, oil, and gasoline. In addition, the Spongex product will not rot or mildew as will natural buoyant materials.

The ring is equipped with mildew-resistant grab line and straps, held together by nylon thread. Approved sizes are 20, 24, and 30 inches in diameter, and the firm also manufactures an 18-inch ring of the same material.



Spongex ring lifebuoy.

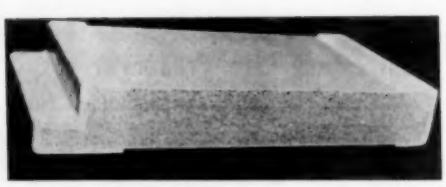
Readers' Service Item P-4

All-Plastic Sandwich Panels

An insulated plastic sandwich construction panel composed of an expanded polystyrene core with a facing of glass fiber cloth-reinforced polyester sheet has been introduced by Haskelite Mfg. Corp. Called Hasko-Struct, the panels are lightweight, strong, and have good thermal-insulating properties.

A wide range of stock sizes and thicknesses are available in core densities up to and exceeding two pounds per cubic foot. The reinforced plastic covering is obtainable in thicknesses of 18 and 32 mils. Standard sandwiches are one, two, three, four, or six inches thick, though special sizes run as high as 18 inches. Standard width is 48 inches, with lengths of 96, 120, and 144 inches begin marketed.

The moisture-proof and corrosion-resistant panels have been tested in several fields, including transportation, construction, cold storage, and refrigeration. The core material used in the panels is Dow Chemical Co.'s Styrofoam.



Hasko-Struct panel in cross-section.

Readers' Service Item P-5

Acrylic Emulsion Binder

An acrylic emulsion designed for use as a binder for boxboard and pigmented paper coatings has been introduced by Rohm & Haas Co. Designated Rhoplex B-15, the material reportedly is characterized by low viscosity, chemical and mechanical stability, the resistance to high mechanical shear and high temperatures.

Rhoplex B-15 coatings dry rapidly, and may be calendered to unusually high gloss at moderate pressures. They are said to provide a smooth printing surface, with good ink hold-out even during high-tack printing. Water-white in color, the binder does not detract from pigment brightness. Films do not shrink, as do those made from starch and casein, nor do they stiffen and embrittle paper.

The emulsion can be blended with other binders to reduce coating costs or to obtain working properties similar to those of protein-based coatings. For example, a 1:1 blend with alpha-protein is said to effect synergism by achieving bounding strength and brightness greater than that obtained with either binder used alone. Gloss, however, will be diminished in proportion to the percentage of added protein.

Specifications include a solids content of 46%; a weight per gallon of 8.7 pounds; particle size less than one micron; and a pH of 6-6.5. The material is stable to most pigments except zinc oxide and certain types of English clays. It is said to be ideally suited to Champion-type coatings, where good coverage must be developed under restricted conditions. Standard clay and clay-titanium dioxide coatings can be formulated with Rhoplex B-15 as the sole binder.

Readers' Service Item P-6

Louvered Acrylic Window

A new type window consisting of a one-piece louvered acrylic panel has been made available by Luria-Cournand, Inc. Named Lura-Lite, the window is said to control glare and solar heat by means of an exaggerated wash-board construction.

Each louver combines a clear transparent surface with an opaque surface, designed to admit light only. Originally developed by Rohm & Haas Co., suppliers of the Plexiglas acrylic material used in the construction, the window may be used in combination with conventional frames to provide a means for ventilation.

Lura-Lite windows are usually installed with horizontal louvers for maximum daylight control, but can be used vertically to provide a degree of visual privacy or to screen objectionable objects to the side. For lighting control at low sun angles, windows are available with translucent rather than transparent surfaces alternating with the opaque. Made to any specification or size, the windows have a flange on each panel to insure weathertight installation.

Luria-Cournand's louvered acrylic window.

Readers' Service Item P-7

Polyethylene Hand Pump

A hand-pump in which all working parts are made of polyethylene is presently available through Bel-Art Products. Called the Poly-Hand-Pump, the unit reportedly has been tested for over 100,000 continuous cycles without showing signs of wear.

Single-acting under positive pressure, the pump delivers a gallon of liquid within a few seconds, and empties a drum or carboy within ⅛-inch of the bottom. Polyethylene was the material of choice due to chemical resistance and the fact that it is unbreakable. The pump is marketed with various fittings, such as a two-inch threaded plug for stock drums, or fitted into a 13-gallon Plax polyethylene carboy. Several sizes are stocked, and the pump may be made to specifications.

Polyethylene hand-pump fitted to polyethylene carboy.

Readers' Service Item P-8

Vinyl Runner Matting

Lightweight Koroseal vinyl runner matting designed for heavy-traffic use has been introduced by B. F. Goodrich Co. Industrial Products Division. Light gray in color, the matting has a bright, glossy surface and is wide-ribbed for ease of cleaning.

Permanently waterproof, the matting is said to show exceptional resistance to abrasion, cracking, chipping, peeling, and rot. Resistant to oil, grease, and most solvents, it can take high temperatures without becoming sticky. Thirty-six inch widths are standard.

Readers' Service Item P-9

Hand-Held Welding Torch

A hand-held, 300 ampere welding torch has been introduced by Linde Air Products Co. Known as the Heliarc, Type HW-10, the torch features a water jacket adaptor capable of withstanding reflected heat as high as 400° F. outside and cooling water inside.

This adaptor was molded by Micro Products Engineering Co. from Bakelite's Fluorothene, a fluorocarbon resin which is said to provide the answer to high heat distortion and moisture resistance. Water circulated internally cools the torch body, power cable, and the jacket around the electrode. Reflected radiation from the powerful arc brought about distortion of the adaptor previously used, with subsequent internal and external leakage.

The Heliarc torch can be used with both high-frequency, stabilized alternating current, and straight polarity, direct current. Tungsten electrodes 0.04-⅛ inch in diameter are gripped in quick-release collets for rapid changing and adjustment.

Linde's Heliarc welding torch. Encircled area shows location of fluorocarbon adaptor ring.

Readers' Service Item P-10

Multi-Purpose Vinyl Sleeving

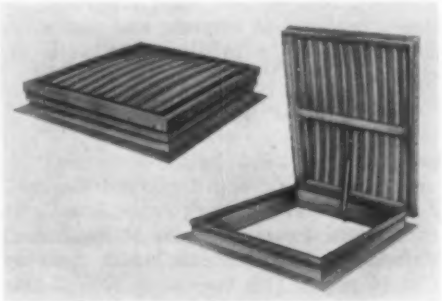
A versatile vinyl insulation sleeving, said to serve both general purpose and specification requirements, has been introduced by Resin Industries, Inc. Designated Resinite EP-69A, the sleeving exceeds all requirements of specification MIL-I-631B, according to company claims.

Working temperatures range from —48° C. to 90° C., and dielectric strength is established at 750 volts per mil. Corrosion, fungus, oil, and flame resistance also exceed specifications. Transparent, black, white, red, and blue tubing is available; sizes from #20 AWG to 2½-inch inside diameter.

Mayer Studios

Resinite EP-69A vinyl sleeving.

Readers' Service Item P-11



Marco Fire-Vent Model skylight.

Reinforced Plastic Skylight

A new skylight product, the Fire-Vent Model, has been developed by Marco Co. Made of fiberglass-reinforced plastic translucent panels set in an extruded aluminum frame, the new product is said to contain all the features of the company's other aluminum and fiberglass panel skylights. The unique construction of the Fire-Vent Model gives automatic and immediate ventilation in case of fire. When fire or excessive heat occurs, a fusible link will separate, causing the skylight's cover section to open and remain open until manually closed. The opening mechanism consists of an aluminum-enclosed spring unit with stainless steel rod.

The new skylight is equipped with a self-contained curb and roof flange, and is designed for installation directly to roof openings without the need for curb construction and curb flashing. The model is made in one standard size only to fit a roof opening of 30 by 36 inches. Colorless and light green units are standard; other colors are available on special order.

Readers' Service Item P-12

Plastic-Hulled Model Boat

The "Flash," the newest racing model hydroplane introduced by Lindberg Products, Inc., has a vacuum-formed plastic hull that provides striking realism, high speed, and rugged durability. The boat is said to hit speeds of 20-25 miles per hour with remarkable stability, even in choppy water. Available in kit form, the hydroplane measures 16¾ inches in length, and is powered by a ½-A outboard motor available in hobby shops.

The boat hull is vacuum formed from 0.040-inch thick Campco S-300 sheet, a rubber-modified styrene made by Campco

Lindberg "Flash" Model Hydroplane

Div., Chicago Molded Products Corp. The hull is made in two sections; the upper section includes the decking and cockpit, while the lower section consists of the stepped hull. After forming, the two sections are joined by a special cementing process developed by Lindberg. The accessories (floor boards, steering wheel, cleats, etc.), which provide authenticity, are injection molded from polystyrene. Parts requiring a metallic appearance are vacuum plated.

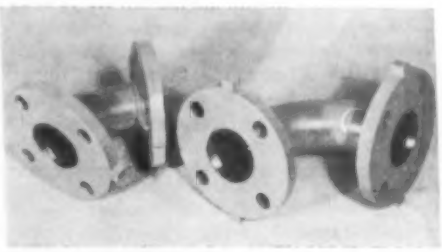
Readers' Service Item P-13

Fluorocarbon Elbow & Bellows

Two new fluorocarbon products have been molded by Resistoflex Corp., for use in applications involving acids and caustics, food and drugs, jet fuels, and gases and vapors under extreme conditions of temperature.

The first, designated Fluoroflex-T pipe elbow, is of short-radius construction. Available in both 45° and 90° angles, the elbow is designed for use with Fluoroflex-T laminated pipe or any ASA flanged piping.

Fluoroflex-T1001 molded bellows consists of bellows and expansion joints. Chemically inert, it is marketed in 1-, 1½-, 2-, and 3-inch diameters. Custom fabricated designs and shapes may be ordered.



Fluoroflex-T pipe elbow, and Fluoroflex-T1001 molded bellows.

Readers' Service Item P-14

New Literature

Write item numbers on Readers' Service card to obtain copies of literature.

"Kel-F Fluorocarbon Oils, Waxes, and Greases." M. W. Kellogg Co. 16 pages. Among the applications included in this booklet are hydraulic pumps, pump fluids, potting and sealing waxes, damping fluids, heat transfer media, permanent lubricants for precision parts, and synthetic lubricants blends. Properties are also given along with specifications and chemical structures.

Readers' Service Item L-1

"Flow-Master Continuous Reactor and Mixing Assemblies." Engineering Bulletin No. 287. Marco Co., Inc. 4 pages. The set-up for a pilot plant or a semi-works using Flow-Master equipment is described and illustrated in this bulletin. This unique unit is adaptable to alkylation, hydrolysis, oxidation, polymerization, esterification, sulfonation, and saponification.

Readers' Service Item L-2

"Quelcor Plastisol Coatings." Data Sheet #75. Quelcor, Inc. 2 pages. Physical properties of the firm's PVC coatings are given, together with a list of the chemicals against which they are effective.

Readers' Service Item L-3

"Plastics Program." Princeton University. 20 pages. This new edition, which marks the tenth anniversary of the school's plastics laboratory, describes the courses and facilities available to prospective students.

Readers' Service Item L-4

"Automatic Plastic Deflashing." Bulletin PE-7. Wheelabrator Corp. 4 pages. This bulletin presents a case history showing how Wheelabrator pellet deflashing cut labor costs by $110 daily. Photos of equipment and material are included.

Readers' Service Item L-5

"Better Yields, Higher Purity from Ethylene Plants by M. W. Kellogg." Chemical Process Div., M. W. Kellogg Co. 8 pages. This bulletin describes and illustrates a new steam-pyrolysis process which permits economic conversion of natural gasoline, residuals, or other low-value refinery products to ethylene and olefins. A flow chart of the pyrolysis process is included.

Readers' Service Item L-6

"Bakelite Compounds for Monofilament Extrusion." Extruderitems No. 2. Bakelite Co. 14 pages. This booklet is divided into three sections covering styrene and styrene-acrylonitrile monofilaments, polyethylene, and vinyl monofilaments. Extrusion techniques, mold design, annealing, coloring, stretching, and property data are included.

Readers' Service Item L-7

"Stan-Tone MBS Colors." Bulletin #02-14-9-55. Harwick Standard Chemical Co. 3 pages. This revision of the company's publication gives the composition, specific gravity, lightness, alkali-acid resistance, and bleeding in water values of the Stan-Tone masterbatch colors.

Readers' Service Item L-8

"Plexiglas in Architecture." PL-236. Rohm & Haas Co. 16 pages. The architectural characteristics of Plexiglas is discussed, together with the types, dimensions, properties, and fabrication of the sheets. Applications described include lighting fixtures, luminous ceilings, window glazing, dome skylights, partitions, signs and facades, and store display fixtures and signs.

Readers' Service Item L-9

"Luminous Ceilings Made with Bakelite Rigid Vinyl Sheets." Bakelite Co. 16 pages. This illustrated brochure describes the properties, installation, and maintenance of Bakelite rigid vinyl sheeting in luminous ceilings; suggests new ways to increase lighting efficiency, economy, and design flexibility; and shows installations in schools, offices, homes, factories, restaurants, and libraries.

Readers' Service Item L-10

"The Story of the Ring-Jet Pump." Bulletin No. 756. F. J. Stokes Machine Co. 8 pages. The "ring-jet" design feature is explained in this booklet, which shows how it makes possible the higher pumping speeds of the company's new diffusion and booster pumps used in high-vacuum processing operations.

Readers' Service Item L-11

"Avisco Cellophane—Characteristics and Uses." American Viscose Corp., Film Division. 6 pages. This pamphlet describes three new cellophane types and several new film designations issued by the company, and gives information on their properties and applications.

Readers' Service Item L-12

"Castor Rheometers, Process Units, Gelometers, and Auxiliary Equipment." Bulletin No. 330. Burrell Corp. 8 pages. This illustrated catalog bulletin describes a new line of equipment manufactured by Burrell for processing and control of dispersions, polymers, and lubricants.

Readers' Service Item L-13

"Staflex KA." Deecy Products Co. 16 pages. Properties and test procedures are given for this phthalate ester-type plasticizer. Methods of use and formulations for calendering and extrusion compounds, plastisols, and organosols are included.

Readers' Service Item L-14

Publications of the chemical division, Goodyear Tire & Rubber Co.:

"Properties—Plio-Tuf C75 for Calendering." No. 55-192. 2 pages. Physical properties for this modified styrene are tabulated and analyzed in this bulletin, along with electrical properties and chemical resistance data.

Readers' Service Item L-15

"Calendering and Laminating Plio-Tuf." No. 55-193. 4 pages. Mixing, stock reworking, feeding, and take-off are described along with the actual operations. Recommendations are included.

Readers' Service Item L-16

"Compounding Plio-Tuf C75 for Calendering." No. 55-194. 2 pages. Two calendering formulations are submitted. Colors, fillers, and extenders suitable for use with the material also are listed.

Readers' Service Item L-17

"TGD-5001." Bakelite Co. 6 pages. This is the first issue of "Bakelite Extruderitems," a new periodical intended to disseminate information on contour extrusion and vacuum forming of the firm's vinyl, polyethylene, and styrene plastics. This issue described mechanical properties, and offers suggestions on processing this high-impact styrene.

Readers' Service Item L-18

"Screen Process Printing on Plactics." Technical Service Bulletin 2. Logo, Inc. 5 pages. The basic equipment, printing operation, and paints for screen printing on plastics are described. A tabulation listing the properties of finishes and colors available from Logo for silk screening is included.

Readers' Service Item L-19

"The Plastics Story." CDP-673. General Electric Co., plastics dept. 8 pages. Included here is a comparative chart of the various plastics available from GE for molding purposes, their characteristics, applications, and specifications. Given also is a similar comparison of the silicone rubber grades available for molding.

Readers' Service Item L-20

"Analog to Digital Conversion in Automatic Weighing." Technical Reference No. 55B. Richardson Scale Co., Clifton, N. J. 2 pages. Description and photographs of the firm's semi-continuous weigher for providing a cumulative indication of pounds of material weighed as the weigher discharges are contained in this publication. The equipment is said to be ideal for non-free flowing adhesive materials.

Readers' Service Item L-21

"Tall Oil for Resins—Part IV." Bulletin No. 16. Pulp Chemicals Association, tall oil division. 4 pages. Suggested uses of tall oil in the rubber, latex paint, and resin industries, together with literature references, are included in this issue of "Tall Oil in Industry."

Readers' Service Item L-22

"Monoplex S-70." Rohm & Haas Co., resinous products division. 5 pages. These technical data sheets report the properties and performance of Monoplex S-70 (formerly Monoplex AG-280), a low-temperature plasticizer for vinyl resins.

Readers' Service Item L-23

"Organic Chlorine Compounds." F-4769. Carbide & Carbon Chemicals Co. 48 pages. Contained in this illustrated booklet are the physical properties, solvent properties, specifications, applications, and test methods for 18 of the firm's organic chlorine compounds used in the synthetic rubber and plastics industries.

Readers' Service Item L-24

"Emulsol Products List." Emulsol Chemical Corp. 6 pages. This revised list is classified by application, including surfactants for technical processing industries.

Readers' Service Item L-25

"Epocast 4-B and 4-B-2 Filled Epoxy Resins." Bulletin EP-54-10a. Furane Plastics, Inc. 3 pages. Physical differences, processing techniques, and factors influencing pot life and cure times are reported in this bulletin.

Readers' Service Item L-26

"Epocast 4-C and 4-D Filled Epoxy Resins." Bulletin EP-55-61. Furane Plastics, Inc. 3 pages. Properties for the finished resins are given along with short descriptions of the hardeners used and data on pot life.

Readers' Service Item L-27

"Durez 13856 Black." Durez Plastics Division, Hooker Electrochemical Co. 4 pages. Complete property data is given on this flock-filled phenolic molding material, along with information on preforming, mold temperature, curing time, and finishing operations.

Readers' Service Item L-28

"Nafil Resin for Polyurethane Foam." Chase Chemical Corp. 4 pages. This folder lists complete technical data as well as suggested uses. Some chemical background is included.

Readers' Service Item L-29

"Molykote Lubricants." Bulletin 103A. Alpha Molykote Corp. 4 pages. Seventeen types of molybdenum disulfide lubricants are listed in a selector chart which describes each type, the kind of carrier used, optimum temperature range, and proper method of application. Ten industrial applications for these solid lubricants are explained in detail.

Readers' Service Item L-30

"Solvent Recovery." Form 4410D. Carbide & Carbon Chemicals Co. 36 pages. Solvent recovery by the Columbia activated carbon system is described in full. Five pages are devoted to equipment used in conjunction with the system, and another 10 pages are devoted to applications.

Readers' Service Item L-31

"Polypenco Nylon, Teflon, and Other Industrial Non-Metallics." The Polymer Corp. of Pennsylvania. 8 pages. This illustrated brochure includes Technical Bulletin No. 11 on nylon applications, and an insert giving nylon formulations and their properties.

Readers' Service Item L-32

"Mobaloy AH." Mobile Plastics Division, Carlisle Corp. 2 pages. This bulletin describes a high temperature-resistant prepreg, giving property data and cure conditions. The material is being tested as a low-pressure laminator for aircraft applications.

Readers' Service Item L-33

"1955 Annual Report." Aetna-Standard Engineering Co. 24 pages. The report also includes illustrated descriptions of the firm's equipment which is used in finishing, coating, and cold drawing. Two pages are devoted to machinery used in the plastics and rubber industries.

Readers' Service Item L-34

"Alsynite Flat Panes and Corrugated Panels." Folder IC-95. Alsynite Co. of America. 4 pages. This illustrated folder gives information on flat and corrugated panes for industrial glazing, with suggested construction details for metal-covered buildings and double-pitched skylights. Installation diagrams are included.

Readers' Service Item L-35

"Dodge Expansion Insert." Phelps Mfg. Co. 4 pages. The design features, stock sizes, and a partial list of users are given for the inserts, intended for use in molded plastic parts, die castings, and all softer materials.

Readers' Service Item L-36

"Syloid 244 for Flatting Vinyl Lacquers." Davison Chemical Co. Product Data Sheet, 5 pages. Extensive test data are given to show that Syloid 244, a silica, will effectively and economically flat the gloss of a typical vinyl lacquer. Comparative results are given for the material, a competitive synthetic silica, and another Davison flatting agent.

Readers' Service Item L-37

Book Reviews

"Research and Development of High Strength Reinforced Plastics for Ordnance Use." Order PB 111721 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 54 pages. Price, $1.50.

This report by the Naval Bureau of Ordnance deals with parallel glass fiber structures through the use of cured thermosetting resin binder systems. Intended for the reinforcement of plastics, the structures feature a binder which is applied to the fibers as they are formed. A degree of adhesion is established which raises flexural strength values of the polyester laminates from 65,000 to 120,000 psi., and also increases modulus values.

The physical-chemical properties of the fibers have been studied in an attempt to produce better products, as well as explain the failure of structures which had been subjected to only moderate loads. Illustrations are included.

"Electrical Insulation and Dielectrics 1955." Edited by Alex E. Javitz. Gage Publishing Co., 1250 Sixth Ave., New York, N. Y. Paper, 8½ by 11 inches, 130 pages. Price, $3.00.

Intended primarily for the design engineer, this manual consists of a compilation of articles selected from recent issues of "Electrical Manufacturing" magazine. These articles approach the subject of electrical insulation and dielectrics from the standpoint of materials application in the design and development of electrically-energized equipment.

Although no new materials have been developed for several years, there has been an intensification of testing and evaluation of materials presently on hand. Increasing interest has been centered on the nuclear radiation of dielectrics; and the expanding range of available formulations, such as the various epoxy alloys, silicone-bearing polymers, synthetic mica combinations, and glass-fiber materials.

The following topics are covered in this manual, complete with photographs, tables, references, and an annotated bibliography: epoxy-imbedded circuits and components; arcing problems encountered in aircraft relays and switches; results of dielectric strength testing of solid insulation materials at frequencies ranging from 60 cycles to 100 megacycles; the effect of high-energy radiation on dielectrics; a study of the deteriorating effects of heat and corona; an analysis of the physical and electrical properties of ferroelectric dielectrics; applications for gas and liquid insulation; a step-by-step analysis of glass-premix compounds; special properties of filled fluorocarbons; an evaluation of the dielectric properties of plastics laminates; effects of humidity on thermosetting laminates; temperature classification of insulating materials; and European developments in the field of dielectrics.

"The Spectral-Transmissive Properties of Plastics for Use in Eye Protection." American Standards Association, Inc., 70 E. 45th St., New York, N. Y. Paper, 8½ by 11 inches, 48 pages. Price, $1.50.

Data on the ultra-violet, luminous, and infrared transmissive characteristics of plastic materials are considered, and compared with those of glass. The use of plastic eye protectors is considered from the standpoint of the four types of hazards encountered in industry; namely, mechanical, heat, chemical, and radiant energy. Statistics were supplied by the Battelle Memorial Institute through an investigation sponsored by the National Safety Council.

Uses for plastics in eye protection include molded lenses, contact lenses, cover and filter lenses, head and face shields, television glasses and filters, sunglasses, and glasses for night driving. Numerous tables indicating spectral transmittances and tolerances of representative samples are given. This report has the approval of the Committee on Eye Protection which is sponsored by the U. S. Department of Commerce, National Bureau of Standards, U. S. Bureau of Mines, and the U. S. Navy Department.

"Adsorption Studies on Polyvinyl Acetate and Polyvinyl Butyral Wash Primers." Order PB 111701 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 48 pages. Price, $1.25.

This illustrated progress report was prepared by the Polytechnic Institute of Brooklyn for use by the Office of Naval Research, and covers the period of February 1 through July 31, 1954. Experimental results indicate that the amounts adsorbed are functions of molecular weight. These functions vary greatly with the solvent used, running inversely with solvent power. General function of the resin in the wash primer and as an assistant for corrosion protection is also discussed.

"Quote . . . Unquote"

Plastics Objectives in Building

"The phenomenal growth of the plastics industry during two decades has resulted in a considerable body of experience with the properties and performance characteristics of a wide range of plastic materials. Because many of the inherent properties of plastics differ widely from those of the traditional materials of the building industry, designers, fabricators, and producers entering this field face many new problems. Both in details of execution and in broad assumptions of design, the familiar limitations of the past may occasionally be disregarded or more frequently circumvented by the use of different fundamental approaches.

"As a result, it becomes important for designers, fabricators, and producers in this field to develop a thorough understanding of the materials' basic properties and of the potentialities of new engineering combinations; this understanding must be balanced with a heightened sense of the broad objectives of any proposed product in terms of the functions of the buildings in which it will be used and the desires and needs of the people who will be served. The broad scope offered by plastics carries with it the duty to study carefully the objectives and means of building design."

"House of Tomorrow" Program Brochure
Massachusetts Institute of Technology
Cambridge, Mass.

• • •

Technology in Education

"Two great revolutions have taken place in the field of education in the last half century, one cultural and one social. Each has resulted from the impact of expanding technology and industrial advancement.

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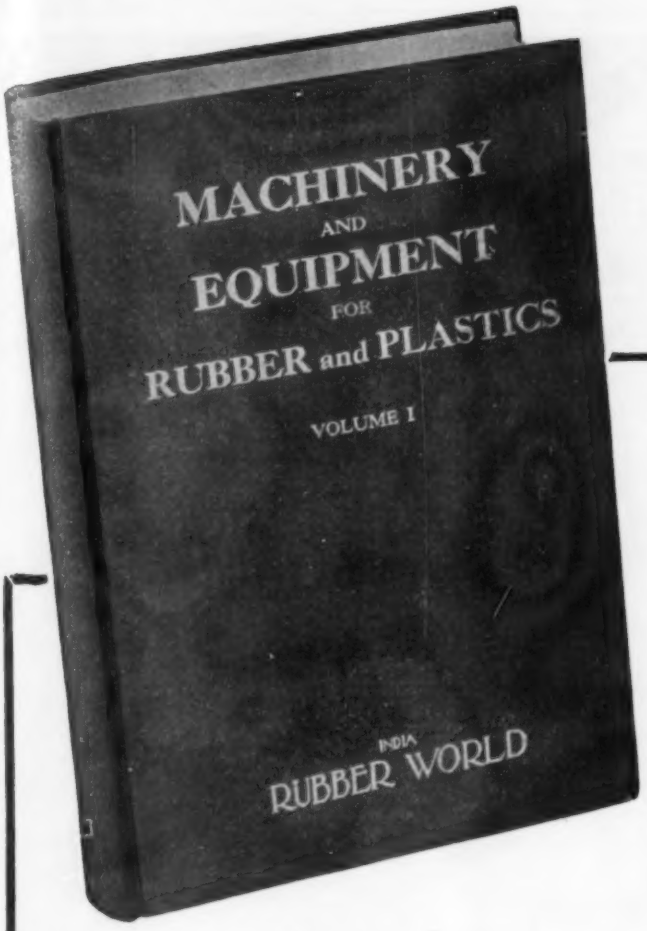

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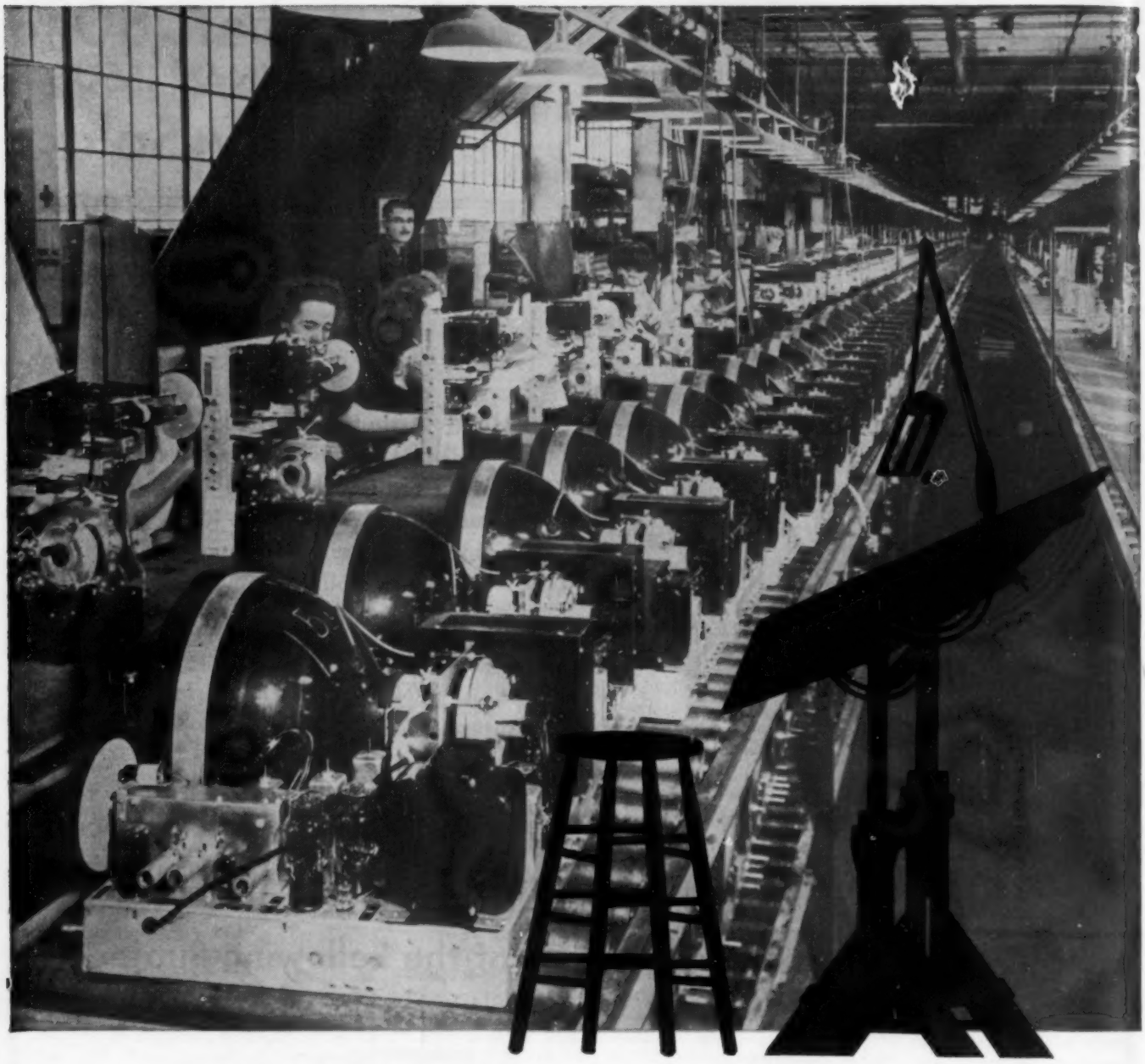

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Abstracts of Important Articles

Materials

"Silicones," G. B. Ingram, *Trans. Plastics Inst.*, (London), 23, 54, 258 (Oct. 1955).

This is the brief story of silicones and what they mean to the modern world. The author covers the manufacture of silicones: the preparation and applications of silicone fluids (as mold-release agents, antifoams, and water-repellants for various surfaces); and the production and applications of silicone rubbers and resins. There is growing interest in Britain in silicone resins for waterproofing masonry.

"Polyamide Moldings with Homogeneous Morphological Structure," W. Hechelhammer, *Kunststoffe*, 45, 10, 414 (Oct. 1955).

During the cooling of a caprolactam-based polyamide molding, the thread-like molecules arrange to form a structure of crystalline and amorphous zones in which the ratio of the respective zones and, consequently, the properties of the molding depend on the conditions of cooling. Tests have shown that the crystalline structure can be influenced by appropriate after-treatment at temperatures above the optical melting point. When the temperature is above a certain critical limit, a homogeneous spherulitic structure results, the size of the spherulites increasing with rising temperature. When the temperature is between the optical melting point and the critical limit, a homogeneous fine-grained structure is obtained. The author describes various tests, and suggests ways in which the process might be put to practical use. (In German).

"The Use of Isocyanates in the Plastics and Rubber Industries," A Hochtlen, *Trans. Plastics Inst.*, (London), 23, 54, 273 (Oct. 1955).

The author describes the method and chemical mechanism involved in producing polyisocyanates and their products, including the rubber-like Vulkollans and the foamed materials or Moltoprenes. The factors influencing properties are discussed. Recent work at Leverkusen on casting large parts from Vulkollan has led to the construction of a continuous apparatus which, on a laboratory scale, is giving good results and seems promising for factory use. It was possible to make castings weighing up to 20 kgs. Moltoprene foam can be produced in both rigid and elastic forms. In addition to other applications, the latter is expected to aid in X-ray technique because of its excellent permeability to X-rays. Tests on rigid Moltoprene at Leverkusen show that it can be used to insulate large complicated parts employed in chemical engineering because foaming can be done *in situ*. Another field of application being explored is in the manufacture of jigs and tools from reinforced plastics. It seems that such tools become particularly strong and wear-resistant if provided with a core of rigid Moltoprene. Finally, the use of polyurethane products for coating textiles, and as adhesive in rubber-to-metal bonding are briefly mentioned.

"Polymers—Manufacturing Operations," J. Lawrence Amos and A. F. Roche, *Ind. Eng. Chem.*, 47, 12, 2441 (Dec. 1955).

The following types of unit operations involved in plastics manufacture are discussed: heat transfer, movement of polymer solutions, process controls, methods of removing volatile from plastics, methods of polymerization, and partial polymerization. Tables and graphs are included.

"A New Type of Polyethylene. Part I," G. Schulz and K. Mehnert, *Kunststoffe*, 45, 10, 410 (Oct. 1955).

It is proposed to discuss the properties, processing, and possible fields of application of the new low-pressure polyethylene, Hostalen, in this series. This first part presents a short introduction to the polyethylene field, followed by a detailed discussion of the physical properties and the chemical resistance of the material. Because of the difficulty of obtaining reliable values for the molecular weight of polyethylene, this value is not used to characterize the Hostalen grades; instead, use is made of the reduced viscosity. How this value is obtained and correlated with the degree of polymerization, is explained. A viscosity measure for judging processibility of Hostalen, is the fusion index which indicates how many grams of the product heated to 190° C. can be extruded in 10 minutes from the standard nozzle of a cylindrical chamber by a plunger having a specific load of three kg./sq. cm. The fusion index decreases with increasing degree of polymerization. (In German).

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

"Highly Filled Fibrous Glass-Reinforced Polyester Molding Compound," R. F. Shannon and L. P. Biefeld, *Modern Plastics*, 33, 3, 133 (Nov. 1955).

The compound, which contains 5% glass by weight, has good physical properties. A continuous method for mixing and pelletizing the compound is discussed, and the material is shown to be easily compression molded. The physical properties of fibrous glass-reinforced polyester molding compositions is said to be not directly proportional to glass content.

"A Method for the Interpretation of Brookfield Viscosities," R. L. Bowles, R. P. Davie, and W. D. Todd, *Modern Plastics*, 33, 3, 140 (Nov. 1955).

Some of the reasons why ordinary viscosity data may be ineffective are discussed. Simple "correction equations" which make the Brookfield Synchro-Lectric VisCometer more applicable to problems are desribed.

Equipment

"Low Shear Viscometry . . . The Squibb Viscometer," R. R. Myers and A. C. Zettlemoyer, *SPE J.*, 11, 7, 43 (Sept. 1955).

Details on the design and construction of the Squibb viscometer are given, and data on test results are presented to show the instrument's use and application.

"Automatic Control of Hydraulic Presses and Injection Molding Machines," J. Krause *Kunststoffe*, 45, 10, 439 (Oct. 1955).

After outlining the advantages of automatic control of operating cycles, the various ways in which this is achieved are discussed. A number of systems in use in Germany, the United States, England, and Switzerland are described, and their limitations explained by the essential differences between water and oil hydraulics. The choice and arrangement of electrical attachments are also dealt with. Finally, the economics of fully automatic plastic presses are briefly considered. (In German.)

"New Rewind Apparatus for Blown and Calendered Film," W. Schmitt, *Kunststoffe*, 45, 10, 453 (Oct. 1955).

The author describes two types of take-off and rewind apparatus that can be attached to machines actually producing blown and calendered film, and which appear to take into account the stress conditions in the material. In the first, for blown film, the squeeze rolls and spread, cutting, and wind-up devices all are combined in a single machine. The second, still in an experimental stage, is intended for calendered sheet, and is designed to accommodate two, three, or four rewind units, each with its own winder and generator. It is provided with a tiltable frame for carrying the wind-up shaft, and has feed and cutting devices. (In German.)

"Stock Thermocouples, Pressure Gauges, and Rupture Disks for Use on Plastics Extruders," E. C. Bernhardt, *SPE J.*, 11, 9, 25 (Nov. 1955).

This paper illustrates and describes thermocouples and pressure gauges which have been designed especially for use on standard plastic extrusion equipment. A simple safety device to guard against the build-up of excess pressure in the extruder head also is described.

"Low-Cost Molds for Short Runs," A. M. Creighton, Jr., *Modern Plastics*, 33, 3, 121 (Nov. 1955).

The production of cast molds, composed of powdered metal and catalyzed thermosetting resin, is discussed.

"Extrusion Dies and Take-Off Equipment," K. O. Robbins, *Modern Plastics*, 33, 4, 125 (Dec. 1955).

An examination of the design fundamentals of current extrusion dies and take-offs, with emphasis on die types, adapter set-ups, land length, sheeting dies, haul-offs, and sheet cutters.

Processing

"Quality Control for Custom Molders," J. B. Whitted, Jr., *Modern Plastics*, 33, 3, 117 (Nov. 1955).

A plan is presented which the practical engineer can readily apply to up-grade the quality of molded plastic parts.

"Hints on Making Films and Hollow Articles by the Extrusion-Blow Method," A. H. Eckhardt, *Kunststoff-Rundschau*, 2, 9, 317 (Sept. 1955).

Suggestions are made on the pre-treatment of various materials (including Ziegler polyethylene), the suitable working temperatures, and additional apparatus that can be constructed in the factory. Some designs of equipment for special cases are discussed, and general directions for processing are given. (In German).

"Methods of Finishing the Surfaces of Thermoplastic Foam," H. Ploenes, *Plastverarbeiter*, 6, 9, 335 (Sept. 1955).

Foamed plastic with decorated surfaces is finding increasing use for various purposes where low abrasion resistance is no serious draw-back, and also a backing for PVC sheet and fabrics, for numerous uses in the home (garments, upholstery, etc.) The author gives a few hints on embossing, color-embossing, printing, and laminating foamed plastics, also on covering them with PVC or fabric. (Iu German).

"Injection and Transfer-Molding of Unplasticized Vinyl Halide Polymers," G. Wick and H. Konig, *Kunststoffe*, 45, 10, 425 (Oct. 1955).

At the Chemische Werke Huls A.G. two methods have been developed for economic mass production of moldings from rigid vinyl halide polymers by the injection and transfer molding processes, for which commercially available machinery can be easily adapted. The injection molding process, particularly for rigid PVC, requires the polymer to be heated in the appropriate plasticizing cylinder temperature to a 10-20° below the temperature needed for perfect flow. The desired temperature is attained by forcing the material, under pressure of over 1,500 kg./sq. cm., through a constriction in the cylinder which temporarily divides the flow of the material into several streams before it passes through the nozzle into the mold. The essentials of the new transfer molding process (for plasticized as well as rigid PVC, polyethylene, polyamide, etc.) are that each part of the machine has a very special function, and that the flow of the material within the flow range never stops. Pressures are from 250-700 kg./sq. cm., depending on the complexity of the mold. (In German.)

"Practical Application of the Holofol Process," W. Opavsky, *Plastverarbeiter*, 6 10, 373 (Oct. 1955).

After briefly discussing the genesis of the idea for the Holofol process, the author describes its application to the manufacture of seamless, tubular wrappings of cellulose ester. (In German).

Applications

"Structural Plastics for Aircraft Use in Theory and Practice," L. N. Phillips, *Trans. Plastics Inst.* (London), 23, 54, 325 (Oct. 1955).

The requirements for plastics as primary structure in aircraft, and the way in which these needs are met, particularly the question of pressure, are discussed. The low pressure phenolic resinated asbestos felt molding technique adopted to solve the pressure problem is explained by the example of the manufacture of a typical delta wing at the R.A.E.. Sandwich construction to deal with instability problems under compression loads is described, and the general advantages and disadvantages of structures are considered. Finally, answers are given to two questions: (1) Why can the low pressure technique work?, and (2) Since the resinated asbestos material ages, can a uniform quality product be obtained? The latter question is answered by descriptions of the simple sigma test to determine the age of the felt, and the test to measure inter-laminar adhesion. The sigma value of a felt can be correlated with its molding behavior.

"Plastics in Wall and Floor Coverings," D. C. Lowe, *Trans. Plastics Inst.*, (London), 23, 54, 308 (Oct. 1955).

This paper deals chiefly with the manufacture of phenolic, urea, and melamine laminates for wall coverings; and PVC floorings. The methods used for obtaining decorative surfaces, the importance of the qualities of the paper used, and color problems are discussed. Reference is also made to the use of polystyrene for wall tiles, and the use of a spectrophotometer to help in color matching. Next, the procedure is described for making PVC flooring, as well as the ways of meeting the problems of costs and shrinkage. Future developments are seen to depend on improvement in properties and design of plastic wall coverings, and in the reduction of costs for PVC flooring.

"The Use of Plastics in Service Packaging," D. J. Evans, *Trans. Plastics Inst.* (London), 23, 54, 305 (Oct. 1955).

The hazards which items for the Armed Services must withstand from climatic conditions and transport when packed are considered, as well as the methods to combat them.

General

"How Bulk Material Handling Saves Money," Carl D. Ackerman and F. J. White, Jr., *Plastics World*, 13, 12, 12 (Dec. 1955).

A case history of change-over from bags and fiber drums to portable aluminum bins is cited by Tote System, Inc. National Plastics Products Co. was able to effect considerable savings by the use of a single system and company-owned trucks to convey powdered ingredients. Benefits accrued by the use of Tote bins are enumerated.

"Static Electricity and Its Effects," H. Haase, *Kunststoffe*, 45, 10, 417 (Oct. 1955).

The present state of knowledge and technique in the field of static charges is reported on, with special reference to the prevention of undesired effects of such charges in plastics manufacture. The suitability of specific means and methods is examined, including German devices for measuring static electricity, for rendering surfaces antistatic, and for ionizing air in factories. Finally, ways in which static electricity can be utilized are briefly discussed. (In German.)

"Patents for Inventions," J. W. Crump, *Trans. Plastics Inst.*, (London), 23, 54, 340 (Oct. 1955).

An interesting general and historical survey of patents precedes such useful details as the patentability of a process, the procedure for obtaining patents (covering mainly procedures in Britain and British countries), the International Convention on patents, and patent examination and opposition, terms, fees, and renewal.

Patent Digest

Materials

Synthetic Linear Condensation Polymers Containing Silicon. No. 2,722,524. Stanley Brooke Speck, Marshallton, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Difunctional reactants of the group consisting of an alcohol, an amine, a carboxylic acid, and their ester and amide forming derivatives are polymerized to form a linear condensation polymer of the group consisting of a linear polyamide and a linear polyester. The reaction is continued until a fiber is formed when a rod is touched to the surface of the melt.

Polymerizable Compositions Containing an Unsaturated Carbonate and Polymerization Products Thereof. No. 2,722,525. John A. Price, Stamford, and John J. Padbury, Springdale, Conn. (to American Cyanamid Co., New York, N. Y.).

Vinylene carbonate, acrylonitrile, acrylamide, and allyl gamma-stearamidopropylmorpholinium bromide are copolymerized in the following molar proportions: 91% acrylonitrile, 5.3% vinylene carbonate, 3.2% acrylamide, and 0.5% of the bromide.

Preparation of Finely Divided Cellulose Plastics. No. 2,722,528. Wallace B. Johnson, Hopewell, Va. (to Hercules Powder Co, Wilmington, Del.).

An oil-in-water emulsion containing a film-forming, water-insoluble cellulose ester or ether and a water-immiscible volatile solvent, are heated and agitated to a point above the boiling point of the solvent, but below that of water. By employing pressure, the plastic is precipitated in particles less than 15 microns in size.

Production of Fluoroethylenes. No. 2,722,558. Howard Johnston, Pittsburgh, Calif. (to Dow Chemical Co., Midland, Mich.).

Chlorine and ethylidene fluoride are rapidly passed through a reaction zone which is maintained at a temperature of 500-700° C.; contact time being less than 0.1 second. The products, consisting of 1,1-difluoroethylene, 1-chloro-2,2-difluoroethylene, and 1,1-dichloro-2,2-difluoroethylene, are then separated from the solution.

Fluorocarbon Production at High Temperatures. No. 2,722,559. Mark W. Farlow, Holly Oak, and Earl L. Muetterties, Hockessin, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

In this process, carbon is reacted at a temperature of at least 900° C. with an inorganic ternary oxyfluoride.

Preparation of Siloxanes Containing Carboxy Groups. No. 2,721,856. Leo H. Sommer, State College, Pa. (to Dow Corning Corp., Midland, Mich.).

$XOC(CH_2)_nSi,CH_3)_2X$ is cohydrolyzed with a silane of the formula R_mSiX_{4-m} at a temperature below 50° C. to produce copolymeric siloxanes. X in the first mentioned formula represents a group consisting of chlorine and alkoxy radicals, and R in the second formula stands for a monovalent hydrocarbon free of $C\equiv C$ linkages.

Method of Making Alpha-Cyanoacrylates. No. 2,721,858. Frederick B. Joyner and Gary F. Hawkins, Kingsport, Tenn. (to Eastman Kodak Co., Rochester, N. Y.).

A cyanoacetate is reacted with formaldehyde at 50-90° C. in the presence of a basic condensation catalyst. These materials are in a solution of non-aqueous organic solvent which distills at a temperature below the depolymerization point. Water is removed azeotropically.

Air-Drying Organosilicon Compositions Containing a Titanic Acid Ester. No. 2,721,855. Myron Kin, Midland, Mich. (to Dow Corning Corp., Midland, Mich.).

The composition comprises a benzene soluble polymeric organosilicon compound and from 0.02-1.5% by weight of a benzene-soluble titanic acid ester of an aliphatic alcohol.

Thermally Stable Polysulfone Resins. No. 2,721,851. Robert J. Fanning, Borger, Tex. (to Phillips Petroleum Co., Bartlesville, Okla.).

An olefin-sulfur dioxide resin is stabilized against heat with 1- or 2-naphthalenethiol.

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—The Editor

Polyvinyl Acetyl Modified Silicone-Alkyd Resins. No. 2,721,854. Charles F. Kohl, Midland, Mich. (to Dow Corning Corp., Midland, Mich.).

The composition consists essentially of the reaction product of an organosilicon compound which has been reacted with a polyhydroxy alcohol and a dicarboxylic acid, and a polyvinyl acetal resin.

Cellulose Esters Plasticized with a Condensation Polymer. No. 2,721,850. Philip Richard Hawtin and John Alec John, Spondon, near Derby, England (to British Celanese, Ltd.).

Cellulose acetate having an acid value of 52-56% is plasticized with a liquid condensation polymer of ethylene glycol and a phthalic acid.

Resinous Products. No. 2,721,176. Troy L. Cantrell, Drexel Hill, Pa., John G. Peters, Audobon, N. J., and Herschel G. Smith, Wallingford, Pa. (to Gulf Oil Corp., Pittsburgh, Pa.).

An oil-soluble thermoplastic resin containing both metal and sulfur is prepared by condensing a metal sulfide in aqueous formaldehyde with an amine and an alkylated monohydric phenol.

Aqueous Condensation Process for the Preparation of Polyvinyl Acetal Resins. No. 2,720,501. Robert Terry Van Ness, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

An aqueous polyvinyl alcohol solution is mixed with a strong acid catalyst and an aliphatic aldehyde. This mixture is pumped in a recirculating loop at a temperature of 50-95° C., a continuous side stream being drawn off at 1/10 the flow rate in the loop. This material is collected and maintained at 60-100° C. until the degree of acetalization is essentially completed. The pH is then raised from 5 to about 7, the excess aldehyde is removed, and the resulting polyvinyl acetyl resin is stabilized by raising the pH to 8 or over.

Tetra-Alkyl Lead Catalysts for the Preparation of Polyesters. No. 2,720,505. John R. Caldwell and John W. Wellman, Kingsport, Tenn. (to Eastman Kodak Co., Rochester, N.Y.).

The polyester is prepared by condensing under anhydrous conditions, an aromatic dicarboxylic acid diester of the general formula $R_1OOC\text{-}R_2\text{-}X\text{-}R_3\text{-}COOR_4$.

Equipment

Production and Packaging of Plastic Materials. No. 2,720,737. Clarence W. Vogt, Norwalk, Conn.

The apparatus for producing plastic packages has an enwrapment support with angularly disposed receiving surfaces ar-

ranged in a V-shape. A means carries the plastic mass onto the enwrapment where it is enfolded. The depositing means is then removed laterally through an opening in the tubular enwrapment.

Extrusion Press. No. 2,720,970. Pierre Roux, Paris, France.

The press comprises a bed with a longitudinal passage, a longitudinally-movable container, and a die assembly and support between the bed and container which moves transversely to bring about register. A removable fastening means secures the die assembly to the support and to the container, whereby the die assembly is longitudinally moved away from the bed on movement of the container.

Blow Tube for Shell Molding. No. 2,721,363. Lewis A. Taylor, Bedford, Ind. (to General Motors Corp., Detroit, Mich.).

The machine comprises a hot pattern and a blow tube with an elongated, tubular body portion. An opening, which extends throughout, conveys a molding mixture of dry sand and a thermosetting binder to the molding surface of the pattern. Retainer pins extending between opposite walls of the tube near the outlet prevent passage of the mixture through the tube after blowing.

Abrading Apparatus for Mold Patterns. No. 2,722,090. Victor H. Hasselquist, Akron, O. (to B. F. Goodrich Co., Akron, O.).

This device for abrading a mold face consists of a carriage, a removable frame support, and a rotatable abrasive disc. The latter is supported in a vertical plane toward and away from the carriage, and a means on the opposite end provides for translational movement when the frame is disengaged from the carriage.

Processing

Acrylonitrile-Styrene Copolymer Filaments and Process of Producing Same. No. 2,721,785. Walter J. Zybert, Morris Township, Morris County, N. J. (to Allied Chemical & Dye Corp., New York, N. Y.).

Acrylonitrile and styrene are copolymerized in aqueous emulsion using an inorganic polymerization catalyst and temperatures not above 75° C.; monomer weight ratios being approximately 4:1, respectively. The copolymer is then dissolved in dimethyl formamide, and the viscosity adjusted to 300-1,000 poises. Filaments are then extruded into a water bath, wherein the dimetyl formamide content is reduced to about 50-80% by weight. Water enters the filament to form a surface-gelled filament having a tensile strength of at least 0.1 gram per denier. Dimethyl formamide content is further reduced to 8% by passing the filament through an evaporating zone where the temperatures range from 130-150° C. The solid filament is then stretched to 250-1,400% its original length.

Method of Making Electrically Conductive Polystyrene Articles. No. 2,721,357. Frederick Hochberg, Red Bank, N. J. (to United States of America as represented by the Secretary of the Army).

Styrene molding powder having a particle size of 60-80 mesh is plated with a continuous, thin silver film by chemical reduction methods. The plated powder is then molded at temperatures lower than conventional molding temperatures, and at markedly higher pressures.

Heat Stabilizing of Cellulosic Insulation in Electrical Apparatus. No. 2,722,561. Leon McCulloch, Pittsburgh, Pa. (to Westinghouse Electric Corp., East Pittsburgh, Pa.).

Cellulosic insulation in contact with electrical windings is protected against the loss of physical strength due to heat by the application of a liquid dielectric petroleum oil. Placed between the cellulosic and the winding, it dissipates the heat. Urea present in the oil also helps to maintain the cellulosic's physical strength.

Printed Plastics and Method for Producing Same. No. 2,721,821. Keith S. Hoover, Elmhurst, Ill. (to A. B. Dick Co., Niles, Ill.).

Printing on thermoplastics which absorb practically no infra-red rays is accomplished by contacting the plastic surface with an inked surface, also non-absorptive to infra-red rays. Infra-red absorbing ink is rapidly built up on the carrier surface to form a head pattern and, being heat-generating, softens the plastic material to imprint the desired image.

Process for Printing on Plastic Materials. No. 2,722,038. Erich A. Freund, Chicago, Ill.

Thermoplastic sheet material is heated to its softening point and pressed against a heated printing plate which has been inked with a compound containing a paraffin or wax. This prevents the ink from baking on the plate and brings out precise image definition.

Method for Producing a Vinyl Coated Fabric. No. 2,722,495. William D. Hedges, Columbus, O. (to Columbus Coated Fabrics Corp., Columbus, O.).

Vinyl resin is extruded in sheet form onto a continuous support belt and calendered. A vinyl paste is applied, the fabric rolled on, and the laminate is stripped from the belt and heated to fuse the layers.

Applications

Plastic Pipe with Attached Tensile Load-Bearing Member. No. 2,722,237. Robert W. Rosel, Columbus, O. (to Yardley Plastics Co., Columbus, O.).

The plastic pipe is formed of flexible material, the wall of which has an integral exterior rib extending longitudinally. A flexible metal, tensile load-bearing member is embedded in the rib and extends along the entire length. Completely separated from the pipe wall by the rib section, it can easily be exposed.

Molded Laminated Pulley and Method of Making Same. No. 2,722,130. Lewis E. Caldwell, Greensburg, Pa. (to Westinghouse Electric Corp., East Pittsburgh, Pa.).

The composite pulley consists of a bushing and a web of fibrous material impregnated with a condensation resin which extends radially outward. The web's outer portion comprises superimposed layers of spirally-wound fibrous strips, impregnated with a thermosetting resin. This also serves to define the cable groove.

Multiple Chamber Container. No. 2,721,552. William Andre Nosik, Cleveland Heights, O.

An all-plastic multiple chamber comprises an accessible receptacle; a thin sheet member in sealed engagement with and extending across the opening; a deformable closure in sealed engagement with the chamber and forming a second chamber; and a tubular piercing member.

Adhesive Bandage. No. 2,721,550. Peter S. Banff, Alamo, Tex. (to C. L. Klinck, Jr., McAllen, Tex.).

The bandage comprises a piece of adhesive tape in the form of a flexible fabric backing and a coating of permanently-tacky pressure-sensitive adhesive. The pad is backed by a strip of thermoplastic film, the marginal portions of which are faced with o roughened thermoplastic strip for adhesive protection.

Dual-Welt Plastic Ship. No. 2,721,341. Henry B. Roberts and Elwood S. Wood, Jr., Salisbury, Md. (to Roberts Industries, Salisbury, Md.).

The ship's hull-shell is composed of a resinous material, the bottom being formed of a pre-molded section. Marginal edges are formed with accurately-turned lateral flanges in contiguous relationship to each other. These form a fillet receiving groove on their facing surfaces which is then filled with a resinous binder.

Domestic Production and Sales of Plastics and Resin Material, August and September, 1955

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of March and April, 1955. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

As with last month, over-all gains are explained by preparations for fall sales. Polyesters and Polyethylenes did not, however, reflect this general trend.

	August		September	
	Production	Sales	Production	Sales
Cellulose Plastics:[1]				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,512,198	1,403,540	1,885,671	1,824,280
Sheets, 0.003 gage and over	1,236,903	1,209,679	1,422,689	1,366,088
All other sheets, rods, and tubes	641,203	569,659	703,351	755,538
Molding and extrusion materials	7,680,778	7,423,559	8,728,142	8,852,976
Nitrocellulose sheets, rods, and tubes	412,698	451,359	395,830	394,766
Other cellulose plastics	332,270	220,747	429,521	439,780
TOTAL	11,816,050	11,278,543	13,565,204	13,633,428
Phenolic and Other Tar-Acid Resins:				
Molding materials[2]	17,887,677	16,455,707	18,166,954	16,465,362
Bonding and adhesive resins for—				
Laminating (except plywood)	5,583,255	4,417,098	5,823,224	4,723,104
Coated and bonded abrasives	1,099,595	1,255,971	1,370,881	1,468,037
Friction materials (brake linings, clutch facings, and similar materials)	2,042,808	1,808,171	2,230,367	1,992,004
Thermal insulation (fiber glass, rock wool)	4,512,045	4,533,092	5,171,730	5,316,570
Plywood	3,285,710	2,731,196	3,857,249	3,407,927
All other bonding and adhesive uses	2,191,620	2,266,414	2,334,632	2,381,168
Protective-coating resins, unmodified and modified except by rosin	2,070,024	1,926,552	2,481,274	2,196,678
Resins for all other uses	2,484,531	2,452,753	3,266,411	2,594,720
TOTAL	41,157,265	37,846,954	44,702,722	40,545,570
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	3,154,619	3,037,256	3,410,196	3,467,489
Paper-treating and paper-coating resins	1,984,249	2,096,572	1,965,747	2,104,952
Bonding and adhesive resins for—				
Plywood	8,519,521	8,926,025	9,031,452	8,395,640
All other bonding and adhesive uses, including laminating	2,503,376	2,516,751	2,727,023	2,322,257
Protective-coating resins, straight and modified	3,338,641	2,422,789	3,258,472	3,038,263
Resins for all other uses, including molding	6,254,207	6,726,921	7,146,022	7,725,939
TOTAL	25,754,613	25,726,314	27,538,912	27,054,540
Styrene Resins:				
Molding materials[3]	33,931,323	31,068,927	35,057,204	31,893,789
Protective-coating resins, straight and modified	8,317,078	7,553,167	8,002,658	7,613,842
Resins for all other uses	7,212,391	7,053,522	15,246,994	8,299,659
TOTAL	49,460,792	45,675,616	58,306,856	47,807,290
Vinyl and Vinyl Chloride Resins:[4]				
Polyvinyl chloride and copolymer resins (50% or more polyvinyl chloride) for—				
Film (resin content)		6,477,682		6,982,807
Sheeting (resin content)		3,358,999		4,166,209
Molding and extrusion (resin content)		13,265,299		15,412,328
Textile and paper treating and coating (resin content)[3]		5,135,925		5,582,234
Flooring (resin content)		4,599,162		4,707,365
Protective coatings (resin content)		2,104,670		2,313,374
All other uses (resin content)		4,758,970		4,016,903
All other vinyl resins for—				
Adhesives (resin content)		2,867,758		3,071,897
All other uses (resin content)		8,798,669		9,128,676
TOTAL	57,022,155	51,367,134	60,967,888	55,381,793
Coumarone-Indene and Petroleum Polymer Resins	22,613,557	22,874,389	23,599,090	23,748,913
Polyester Resins:				
For reinforced plastics	4,446,431	3,892,570	3,803,282	4,010,947
For all other uses	293,151	147,725	289,239	188,338
TOTAL	4,739,582	4,040,295	4,092,521	4,199,285
Polyethylene Resins	33,188,819	31,176,698	37,214,859	30,613,517
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[5] [6]	3,609,175	3,248,389	4,541,205	4,243,482
Protective-coating resins[5]	266,977	208,407	381,485	233,562
Resins for all other uses[6]	6,346,606	6,313,829	6,873,682	6,476,407
TOTAL	10,222,758	9,770,625	11,796,372	10,953,451
GRAND TOTALS	255,975,591	239,756,568	281,784,424	253,937,787

[1] Includes fillers, plasticizers, and extenders.
[2] Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3] Includes data for spreader and calendering-type resins.
[4] Includes data for acrylic, nylon, silicone, and other molding materials.
[5] Includes data for epichlorohydrin, acrylic, polyester, silicone, and other protective-coating resins.
[6] Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.

SOURCE: United States Tariff Commission, Chemical Division.

Industrial News Briefs (Cont'd. from pg. 42)

Kentucky Color & Chemical Co., Louisville, Ky., is now in production on a new color series, Cadmium Lithopone Yellows, in primrose, lemon, and medium shades. According to the company, the pigments are heat and light stable and resistant to alkalis, and are adapted to the production of heat-resistant enamels, emulsion paints, leather finishes, tin printing inks, and plastic goods of all types.

Borden Co.'s chemical division, New York, N. Y., is marketing succinic acid in commercial quantities. Formerly available only on a limited basis, the chemical is used in the formulation of plasticizers, polyesters, alkyd resins, paints, pharmaceuticals, cosmetics, and chemical intermediates.

Dow Chemical Co., Midland, Mich., has announced the elevation of its New Orleans, La. office to full sales office rank, as part of the over-all plan to broaden sales activities and decentralize administrative functions. Robert J. Minbiole has been appointed office sales manager.

Visking Corp.'s plastics division, Terre Haute, Ind., has been accepted for membership in the Building Research Institute, a part of the Division of Engineering & Industrial Research, National Academy of Sciences—National Research Council.

Phillips Chemical Co., Bartlesville, Okla., will establish a new district sales office in Akron, O., this spring for its plastics sales division. W. M. Larsen will manage this new office; he formerly was marketing assistant in the sales department of the parent firm, Phillips Petroleum Co. M. B. Bistline has been named a sales engineer at the company's New York plastics sales office. Mr. Bistline was a development engineer in Phillips' research and development department.

Hobbs Mfg. Co., Worcester, Mass., has announced a 5% increase in the price of its line of blades for Jacques and Jacques, Jr., hand operated shears. The shears are widely used for cutting paper, fabrics, plastics, and rubber.

Acheson Dispersed Pigments Co., has doubled the ADP pigment productive capacity at its Orange, Tex. plant to meet increased demand by the plastics industry.

Lunn Laminates, Inc., Huntington Station, N. Y., has reorganized its sales division following a national market research program. It had been found that reinforced plastics sales problems were unique from other industries, and steps taken on the basis of the findings are reportedly responsible for the company's 60% gain in the last quarter.

Manufacturing Chemists' Association, Inc., Washington, D. C., has announced the addition of four new member companies, as follows: Goodrich-Gulf Chemicals, Inc., Cleveland, O.; Mobay Chemical Co., St. Louis, Mo.; Pitt-Consol Chemical Co., Newark, N. J.; and United Rubber & Chemical Co., Charleston, W. Va. The MCA represents more than 90% of the productive capacity of the chemical industry.

Dow Chemical Co., Midland, Mich., has opened a new sales office in Buffalo, N. Y., to serve New York State east to Utica and a 10-county section of northwest Pennsylvania. Manager of the office is E. L. Martinez, formerly with the company's New York City offices, and the sales staff includes S. H. Mott, Jr., G. L. Mitchell, R. D. Visger, R. F. Bunker, R. S. Crew, and D. W. Ruoff. The staff is expected to be enlarged early this year.

Hooker Electrochemical Co., and Niagara Alkali Co., both of Niagara Falls, N. Y., have approved a formal agreement for the consolidation of the two firms, subject to the stockholders' approval. Under the proposed terms, Hooker will be the continuing company and 1.6 shares of Hooker common stock will be issued of the 600,000 Niagara common shares.

January 18-20
SPE 12th Annual Conference, Hotel Statler, Cleveland, O.

January 25
SPE Quebec Section, Queens Hotel, Montreal, Can.

February 2
SPE Southern California Section, Scully's Restaurant, Los Angeles, Calif.

February 7-9
SPI 11th Annual Reinforced Plastics Conference, Hotel Chalfonte-Haddon Hall, Atlantic City, N. J.

February 8
SPE Newark Section, Military Park Hotel, Newark, N. J.

February 9
Fort Wayne Rubber & Plastics Group, Van Orman Hotel, Fort Wayne, Ind.

February 13
SPE Cleveland-Akron Section, Spanish Tavern, Brecksville, O.

February 15
SPE New York Section, Joint Meeting with Reinforced Group, Gotham Hotel, New York City.

February 16
SPE Eastern New England Section, Hotel Beaconsfield, Brookline, Mass.

February 20
SPE Southern Section, Mammy's Shanty, Atlanta, Ga.

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Current Market Prices

This listing is as comprehensive and up-to-date as possible. The full listing will appear quarterly, while intervening issues will carry a briefer tabulation of price changes and additions.

Companies whose products do not appear are invited to submit price data for inclusion in the listing. All suppliers are requested to submit product additions and price changes promptly as they occur, in order to make this listing of maximum value to our readers.

Prices, in general, are f.o.b. works. Ranges indicate quantity or grade variations. No guarantee of these prices is made, and spot prices should be obtained from the individual suppliers.

—The Editor

Adhesives

Ampcoflex Adhesive	gl.	$2.75 /	$3.50
Bakelite BC—17613	lb.	.54 /	.84
BCU-40	lb	.18 /	.48
BR-11938	lb.	.285 /	.585
Bonding resins, abrasives	lb.	.20 /	.915
Brake linings	lb.	.215 /	.6275
Foundry resins	lb.	.2075 /	.395
Heat Insul. resins	lb.	.1425 /	.37
CD Cement Nos. 200, 201, 202, 203, 204	gl.	$0.94 /	$1.50
PS-7	gl.	2.12 /	2.90
Epoxy Adhesive A-1, A-3			
A-4	gl.	4.45 /	6.90
A-2, A-5	gl.	5.60 /	8.00
A-6	gl.	5.80 /	8.00
C-1, C-2, C-3, C-9	gl.	5.60 /	8.00
C-4, C-7	gl.	3.69 /	5.30
Flexible Resin No. 1	gl.	4.45 /	6.90
G-E 12316	lb.	.30 /	.39
12353	lb.	.225 /	.385
Melmac 401	lb.	.45	
421	lb.	.45 /	.47
Melurac 300, 302	lb.	.25 /	.29
301	lb.	.28 /	.33
Metlbond 2002-14	gl.	1.84 /	5.00
4021 Type I	sq. ft.	1.43	
Type II	gl.	1.29 /	3.20
Type III	gl.	1.49 /	3.50
Plaskon Phenolic Bonding Resin	lb.	.16 /	.21
Urea Adhesive 330-11L	lb.	.1875/	.2175
Liquid Adhesive, 2L Types	lb.	.105 /	.115
WR Types	lb.	.0675/	.125
Spray Dried Adhesives	lb.	.18 /	.29
Plastic Cement	gal.	2.25 /	2.70
Pliobond 20	gal.	4.50 /	7.00
30	gal.	5.25 /	8.00
Polyester Foam Cement PC-232	gal.	2.40 /	2.90
Schenectady SP-7401	lb.	.29 /	.31
Schwartz Vinyl Cement	gl.	1.24 /	1.50
Styrofoam Adhesive #5	gal.	3.75 /	4.75
Thixons	gal.	3.30 /	9.00
Urac 110	lb.	.205 /	.225
115	lb.	.24 /	.26
180	lb.	.095 /	.12
185	lb.	.1625/	.2175
186	lb.	.0875/	.1125
192	lb.	.07	

Anti-Static Agents

Anstac-2M	gl.	1.75 /	2.00
Logostat	gal.	1.35 /	1.65
Merix Anti-Static #79	gl.	.75 /	3.85
#79-OL	gl.	.75 /	3.85

Catalysts

Advasol	lb.	.4375/	.5375
Aritemp Curing Agent 105	lb.	2.00 /	2.25
Bakelite BH-17618	lb.	.33 /	.63
BHU-53	lb.	.15 /	.45
ERL series	lb.	.67 /	1.195
Cadet benzoyl peroxide, granules	lb.	.98 /	2.00
Paste	lb.	.95 /	2.25
Powder	lb.	1.50 /	2.37
Dichlorobenzoyl peroxide	lb.	3.00 /	4.25
Lauroyl peroxide	lb.	1.90 /	3.50
Methyl ethyl ketone peroxide	lb.	1.85 /	4.00
Catalyst 57	lb.	.12	
196	lb.	.10	
C-110, -180, -180-S, C-110-S, WF-100, -101	lb.	.12	
Curing Agent A	lb.	3.00 /	6.75
B	lb.	3.00 /	4.75
Furane H-736-A	lb.	1.30 /	2.00
Hardener 157	lb.	1.00 /	1.15
175, 179, 191	lb.	.50 /	.65
181, 184, 185, 185-S, M-325	lb.	.12	
342	lb.	1.40 /	1.55
H C Promoter 6%	lb.	.5275/	.6275
12%	lb.	.9025/	1.0025
Het anhydride	lb.	.55	
HN 551	lb.	.95 /	1.40
901	lb.	.36 /	.80
951 Ciba	lb.	.82 /	1.32
951 Furane	lb.	1.30 /	2.00
IC activators		3.00	
Inhibitor	lb.	.98	
Melurac 255, 259	lb.	.35	
Modifier CB-110,WF-61	lb.	.15	
P-27	gal.	10.00	
Plaskon Hardeners, Liquid	lb.	.07	
Powdered	lb.	.10 /	.46
Spray dried	lb.	.10 /	.25
Promoter D-2	lb.	1.60 /	2.00
Quick-Set Accelerator 804	gal.	9.80	
Resolin epoxy hardeners	lb.	1.14 /	2.50
SA Hardener	lb.	.10	
Shell ditertiary butyl peroxide	lb.	1.965 /	2.92
Soligen	lb.	.4825/	.5825

Coating Resins

Bakelite Phenolics	lb.	.28 /	.64
Styrene emulsions	lb.	.1375/	.31
Vinyl acetates	lb.	.295 /	.66
Solutions	gal.	5.10	
Alcohols	gal.	2.27 /	2.76
Butyral resins	lb.	1.04 /	1.24
Chlorides	lb.	.41 /	.61
Chloride-acetates	lb.	.38 /	.66
Modified	lb.	.44 /	.72
CD Strip A	gl.	1.13 /	2.10
Chemigum latices	lb.	.46 /	.60
Dylex K-500, -600, -700, -900	lb.	.30 /	.46
G-E 13110	lb.	.30 /	.39
G.M.I. Polyamide 100	lb.	.51 /	.64
115	lb.	.54 /	.77
Kel-F Dispersion (dry wt.)	lb.	12.00	
Plaskon Alkyds	lb.	.1075/	.3375
Modified	lb.	.15 /	.2625
Ester Gums	lb.	.1425/	.2475
Maleics	lb.	.1825/	.275
Melamines	lb.	.195 /	.435
Phenolics	lb.	.3925/	.475
Modified	lb.	.1825/	.29
Phenolic Laminating Varnishes	lb.	.165 /	.27
Silicone Alkyds	lb.	1.10 /	2.40
Ureas	lb.	.195 /	.435
Pliolite latices	lb.	.30 /	.39
Pliolite N R	lb.	.93 /	1.22
S-3	lb.	.42 /	.44
S-5	lb.	.49 /	.51
Milled	lb.	.54 /	.56
S-7	lb.	.88 /	1.01
Polyfluoron liquid dispersions	lb.	2.65 /	3.85
Paste dispersions	lb.	4.20 /	4.40
Primer 140	gl.	7.88 /	8.25
Schenectady Alkyds SA Type	lb.	.3575/	.38
SE Type	lb.	.3675/	1.435
SEA Type	lb.	.3575/	.38
Styrenated	lb.	.22 /	.2625
Maleics	lb.	.1725/	.23
Phenolics	lb.	.2325/	.53
Modified	lb.	.1825/	.275
Schwartz AT-25	gl.	.63 /	1.00
BE-40	gal.	3.80 /	3.95
Synvaren 631	lb.	.17 /	.25
Synvarite BRLD	lb.	.39 /	.45
Versamid 100	lb.	.51 /	.69
115	lb.	.64 /	.82

Colors

Acheson 0100 Series Paste Dispersions			
Blacks	lb.	.50 /	.81
Blues	lb.	.55 /	2.175
Green	lb.	2.51 /	2.69
Orange	lb.	.67 /	.85
Reds	lb.	1.08 /	1.34
White	lb.	.52 /	.70
Yellows	lb.	.57 /	.75
Advabrite M-10	lb.	2.25 /	2.40
Advance Brightener M.D.A.C.	lb.	12.00 /	15.00
Akron dry blends, reds	lb.	1.08 /	1.23
Yellows	lb.	.58 /	.88
Organic colors, blues	lb.	.75 /	3.60
Greens	lb.	1.35 /	3.95
Reds	lb.	1.10 /	4.40
Yellows	lb.	2.00 /	5.00
Pastes, blues	lb.	1.25 /	1.58
Greens	lb.	1.85 /	1.90
Reds	lb.	1.10 /	1.40
Whit	lb.	.55 /	.60
Yellows	lb.	1.70 /	1.75
Aquablaks	lb.	.085 /	.235
Cabot carbon blacks	lb.	.05 /	.79
Cadmolith Reds	lb.	1.72 /	2.20
Yellows	lb.	1.12 /	1.20
Claremont 4000-series Pastes			
Blacks	lb.	.82 /	1.01
Blue	lb.	.80	
Browns	lb.	.65 /	2.30
Greens	lb.	.80 /	2.15
Orange	lb.	1.58	
Red	lb.	4.15 /	4.80
Silver	lb.	1.02	
White	lb.	.695	
Yellows	lb.	.65 /	2.87
D-Series pastes,			
Blacks	lb.	.47 /	.68
Blues	lb.	.62 /	1.85
Golds	lb.	2.31 /	2.40
Green	lb.	1.86 /	1.88
Oranges	lb.	.70 /	3.65
Reds	lb.	1.10 /	2.57
Silver	lb.	.89 /	.91
Whites	lb.	.45 /	.60
Yellows	lb.	.85 /	1.68
K-Series pastes,			
Blacks	lb.	.58 /	.71
Blues	lb.	.91 /	1.40
Browns	lb.	.82	
Greens	lb.	.94 /	1.41
Metallics	lb.	.91 /	2.47
Orange	lb.	.80 /	3.84
Reds	lb.	1.03 /	5.07
Violet	lb.	2.30	
Whites	lb.	.59 /	.60
Yellows	lb.	.73 /	3.02
Codispersions	lb.	.23 /	.24
Covinylblaks	lb.	.68 /	1.143
Cowaxblaks	lb.	.4075/	.6075
Cyanamid dyes, calcosines	lb.	.81 /	5.57
Nigrosines and indulines	lb.	.39 /	.97
Oils	lb.	.62 /	7.29
Inorganic pigments			
Blues, cobalt	lb.	.305 /	.33
Iron	lb.	.50 /	.52
Ultramarine	lb.	.165 /	.19
Greens, chrome	lb.	.39 /	.45
Oranges, chrome	lb.	.335	
Molybdate	lb.	.465	
Yellows, chrome	lb.	.335	
Zinc	lb.	.275	
Organic pigments			
Blues, alkali, dry	lb.	2.20	
Flushed	lb.	1.17 /	1.25
Molybdated & tungstated	lb.	2.60 /	6.10
Phthalocyanine	lb.	.90 /	3.68
Greens, mol. & tung	lb.	3.20 /	6.20
Phthalocyanine	lb.	1.71 /	3.95
Oranges	lb.	.70 /	3.00
Reds, bon	lb.	1.50 /	2.00
Cadmium	lb.	1.99 /	3.05
Chlorinated	lb.	1.20	
Lithols	lb.	.90 /	.95
Naphthols	lb.	.80 /	3.60
Paras	lb.	1.10	
Rhodamines	lb.	4.45 /	6.40
Toluidines	lb.	1.65	
Violets	lb.	.75 /	4.18
Yellows	lb.	.62 /	2.35

Ferro blues, browns, greens	lb.	.90 /	2.96
Reds	lb.	2.93 /	4.75
Yellows	lb.	.91 /	2.90
Harwick, blues	lb.	1.55 /	4.55
Brown	lb.	3.00	
Greens	lb.	1.55 /	4.50
Oranges	lb.	1.05 /	1.25
Reds	lb.	1.20 /	3.53
Yellows	lb.	.85 /	4.50
Interchemical IC Series			
Black	lb.	.56	
Blues	lb.	.75 /	2.10
Browns	lb.	.64 /	.69
Greens	lb.	.90 /	.99
Oranges	lb.	.78 /	.89
Reds	lb.	1.16 /	2.50
White	lb.	.70	
Yellows	lb.	.95 /	1.65
IVO bone blacks	lb.	.16 /	.2175
Kentucky inorganics, orange	lb.	.44 /	.64
Yellows	lb.	.31 /	.66
Organics, blues	lb.	3.00 /	4.15
Greens	lb.	3.50 /	4.60
Purple	lb.	1.85 /	2.05
Reds	lb.	1.95 /	3.85
Kriegr-O-Dip W Types	qt.	2.63 /	7.80
A Types	qt.	1.52 /	2.25
Laminac color pastes	lb.	.76 /	1.90
Mapico colors, black	lb.	.1325/	.135
Browns	lb.	.1425/	.145
Reds	lb.	.1275/	.13
Tans	lb.	.2075/	.21
Yellows	lb.	.11 /	.1175
Mearimaid Pearls	lb.	14.00 /	25.00
Nacromer Pearls, Series C	lb.	2.15 /	2.25
Series W	lb.	1.50 /	1.60
Pearl Essence, nat	lb.	15.00 /	30.00
Synthetic #100	lb.	1.95	
#300	lb.	1.45	
#600, #900	lb.	2.15 /	2.45
Plastic Color, blacks	unit	.75 /	1.40
Blues	unit	.65 /	1.10
Brown	unit	1.20	
Greens	unit	.65 /	1.00
Reds	unit	.65 /	2.50
Whites	unit	.80 /	1.30
Yellows	unit	1.15 /	1.55
Pliolite S-5 bases with pigment			
Blacks	lb.	.44 /	.49
Blues	lb.	.62 /	1.48
Greens	lb.	.54 /	.58
Oranges	lb.	.61 /	.63
Reds	lb.	.31 /	1.20
Whites	lb.	.42 /	.44
Yellows	lb.	.43 /	.45
PMS polyester colors	lb.	.85 /	2.85
Polystyrene colors	lb.	.65 /	4.30
Polysupra polyethylene blues	lb.	.65 /	5.60
Blacks	lb.	.50 /	.80
Browns	lb.	1.48 /	3.30
Greens	lb.	1.82 /	3.55
Ivory	lb.	.65 /	1.00
Purples	lb.	2.10 /	3.30
Reds	lb.	.70 /	6.30
Silver	lb.	1.50 /	2.95
White	lb.	.60 /	.85
Yellow	lb.	1.45 /	4.25
Polystyrene blues	lb.	.50 /	9.20
Blacks	lb.	.50 /	5.30
Browns	lb.	.95 /	2.55
Greens	lb.	.35 /	7.40
Ivory	lb.	.85 /	1.20
Reds	lb.	.35 /	6.40
White	lb.	.60 /	1.05
Yellows	lb.	1.45 /	2.95
R-C blacks	lb.	5.50 /	21.30
Browns	lb.	4.375 /	15.75
Reds	lb.	.28 /	15.05
Yellows	lb.	3.60 /	14.05
Rez-N-Dye (dry wt.)	lb.	7.50	
Saran colors	lb.	.59 /	1.80
Sherwin-Williams Dispersed Colors	lb.	.55 /	1.97
Inorganic colors, oranges, yellows	lb.	.32 /	.45
Organic colors, blues	lb.	.90 /	3.60
Greens	lb.	1.35 /	3.95
Reds	lb.	.85 /	4.40
Yellows	lb.	.55 /	1.97
Unitane O	lb.	.245 /	.255
OR	lb.	.265 /	.275
Vansul Organic Drys			
Blues	lb.	3.45 /	3.60
Greens	lb.	1.35 /	3.95
Oranges	lb.	2.21 /	3.00
Reds	lb.	.90 /	4.40
Yellows	lb.	2.00 /	2.25
VAP Dry Dispersions			
Black	lb.	1.00	
Blues	lb.	2.90 /	3.60
Greens	lb.	3.20 /	4.05
Oranges	lb.	1.45 /	2.55
Reds	lb.	1.70 /	4.45
Yellows	lb.	1.35 /	2.55
VP-Series Pastes			
Black	lb.	.70	
Blue	lb.	1.65	
Brown	lb.	1.55	
Green	lb.	2.05	
Oranges	lb.	.80 /	2.30
Reds	lb.	1.15 /	2.55
White	lb.	.47 /	.65
Yellows	lb.	.60 /	1.65
VPE-Series Pastes			
Black	lb.	.90	
Blue	lb.	1.85	
Green	lb.	2.10	
Orange	lb.	1.00	
Reds	lb.	1.45 /	2.30
White	lb.	.90	
Yellows	lb.	1.60 /	2.00
VY Chips			
Blacks	lb.	.90 /	1.30
Blues	lb.	1.00 /	2.25
Brown	lb.	1.60	
Greens	lb.	.90 /	2.45
Oranges	lb.	1.00 /	2.15
Reds	lb.	1.40 /	2.70
White	lb.	.65	
Yellows	lb.	.85 /	1.80
Vinylized colors, blacks, whites	lb.	.755	
Blues	lb.	1.16 /	1.18
Golds	lb.	1.51 /	1.57
Green	lb.	1.45	
Metallic	lb.	1.15	
Orange	lb.	.83	
Reds	lb.	1.15 /	2.27
Yellows	lb.	.76 /	1.09
Violite 199, green	lb.	2.95	
200, yellow	lb.	3.75	
PL 3-60, blue	lb.	3.25	
18-70, blue	lb.	3.70	
Witcoblaks	lb.	.075 /	.37
Zopaque, anatase	lb.	.225 /	.235
Rutile	lb.	.245 /	.255

Dispersing Agents

Daxads	lb.	.08 /	.40

Fillers

Advaresin CXF	lb.	.49 /	.55
KF	lb.	.38 /	.44
A. F. D.	ton	26.50 /	60.00
Aluminum Flake	ton	23.50 /	30.00
Cab-o-sil	lb.	.68 /	.75
Calcene NC	lb.	.036 /	.059
TM	lb.	.0375/	.0625
Camel—CARB	ton	12.00	
—TEX	ton	20.00	
—WITE	ton	32.50	
Cotton flocks	lb.	.12 /	.32
Dixie Clay	ton	14.00 /	34.50
Edgar ASP 200	ton	43.00	
900	ton	18.50	
1300	ton	80.00	
Harwick clays	ton	14.00 /	57.00
Flock	lb.	.11 /	.28
Magnesia	lb.	.105 /	.13
Mica	lb.	.075 /	.0825
Pecan Shell Flour	ton	80.00 /	100.00
Stan White 325	ton	8.50 /	11.00
Walnut Shell Flour	ton	55.00 /	100.00
Hi-Sil 101	lb.	.10 /	.155
233	lb.	.09 /	.105
Hydrite	ton	22.50	
Flat	ton	22.50	
PD-10	ton	46.50	
Kalite	ton	50.00 /	65.00
Laminar	lb.	.015	
McMamee Clay	ton	13.50 /	33.00
Multifex MM	ton	110.00 /	125.00
Nytal 200L	ton	27.00 /	50.00
300	ton	37.00 /	60.00
Silene EF	lb.	.06 /	.105
Surfex MM	ton	37.00 /	52.00
Suspenso	ton	33.00 /	48.00
Tamms Satin Talc	ton	22.50 /	46.00
Velveteen R Silica	ton	23.00 /	28.00
Witcarb P	ton	110.00 /	140.00
R	ton	120.00 /	150.00
Regular	ton	56.75 /	85.00
Wollastonite F-1	ton	23.00 /	25.00
P-1	ton	25.00 /	27.00

Finishes

Toy Gloss T-11 H	gal.	2.75 /	4.45
Logoquant colors	gal.	3.35 /	11.95
Silk screens	gal.	1.50 /	6.11
Logoset Series W	gal.	1.72 /	7.64

Flame-Proofing Agents

IC-776 Antimony Concentrate	lb.	.495 /	.51
M&T Antimony oxide	lb.	.29 /	.305

Lubricants

Baselube or Toplube	gt.	2.50 /	4.00
Bomb-Lube	can	1.75 /	2.50
DC-36 Emulsion	lb.	1.36 /	2.50
Garalease 915	gal.	3.80 /	4.50
HSC #35	lb.	1.36 /	1.48
IC-500	gal.	2.50	
-571	gal.	3.25	
-793-10	gal.	3.40	
Lunn-Lease	gal.	4.15 /	4.85
M-1 Mold Release	lb.	3.00 /	4.00
Metasap barium stearate	lb.	.37 /	.42
Calcium 627	lb.	.36 /	.41
Stearate	lb.	.35 /	.40
Magnesium stearate	lb.	.38 /	.43
Mold-Ease Concentrate PCR	qt.	2.50 /	5.85
Mold Release 225	gal.	5.25 /	6.00
235	gal.	6.00	
Mold-Wiz	gal.	4.00 /	6.00
Part-A-Part	gal.	3.05 /	3.75
Partingkote 823	qt.	1.18 /	2.18
Prepoxy	gal.	7.20 /	12.80
Plaskon 8406, 8407	lb.	.30 /	.37
8416, 8417	lb.	.35 /	.42
8429	lb.	.40 /	.47
Releasor Wax No. 826	lb.	2.29	
Sprits	lb.	1.00 /	1.25
SS-452	gal.	2.80 /	4.90
Toplube	qt.	2.50 /	4.00
Vibrin-VPA Parting Agent	gal.	4.25 /	4.65

Mica

Mycalex 385 & 400, rods, 18-in. length		.90 /	3.35
Sheets, 14 x 18 inches		5.70 /	22.40
K, rods, 18-in. length		1.80 /	6.70
Sheets, 14 x 18 inches		11.40 /	44.80
Supramica 500, rods, 18-in. length		1.08 /	4.02
Sheets, 14 x 18 inches		6.84 /	26.88

Miscellaneous

Dutch Boy Bentone	lb.	.44 /	.60
Ben-A-Gel	lb.	.98 /	1.40
Metasap Water Proofing Agent 569	lb.	.21	
PMS Purging Compound	lb.	.35	

Plasticizers

Adipol 2EH, 10A, 810, XX	lb.	.425 /	.455
BCA	lb.	.45 /	.475
ODY	lb.	.47 /	.50
Admex 710	lb.	.325 /	.36
711	lb.	.345 /	.38
744	lb.	.40 /	.435
Akron MP	lb.	.305 /	.0755
Barrett dibutyl phthalate	lb.	.30 /	.34
Dimethyl phthalate	lb.	.275 /	.315
Benzoflex 2-45	lb.	.26 /	.29
9-88	lb.	.32 /	.35
Cabflex DDA, DI-OA, DOA, ODA	lb.	.425 /	.455
DDP, DI-OP, DOP, ODP	lb.	.305 /	.335
Di-BA	lb.	.4325/	.4625
Di-OZ	lb.	.48 /	.5075
HS-10	lb.	.44 /	.47
TCP	lb.	.33 /	.36
Cabol 100	lb.	.02 /	.11
Chlorowax 40	lb.	.155 /	.165
70	lb.	.18 /	.19
70S	lb.	.21 /	.22
LV	lb.	.175 /	.185
Darex dibutyl phthalate	lb.	.30 /	.33
DIOP	lb.	.305 /	.335
DOP	lb.	.305 /	.335
Dinopol 235	lb.	.355 /	.385
IDO	lb.	.305 /	.335
MOP	lb.	.325 /	.355
Dow Plasticizer No. 5	lb.	.315 /	.34
Resin 276-V2,-V9	lb.	.265 /	.325
Drapex 3.2	lb.	.40 /	.49

Dutch Boy Plasticizer			
NL-A10 (DBP)	lb.	.30	.33
NL-A20 (DOP), NL-A30 (DIOP)	lb.	.305 /	.335
NL-C20 (DOS)	lb.	.61 /	.63
NL-F21	lb.	.395 /	.425
NL-F31	lb.	.44 /	.47
NL-F41	lb.	.48 /	.51
NL-A54	lb.	.295 /	.325
Elastex, 10-P, 18-P, 28-P, 90-P	lb.	.305 /	.335
20-A, 60-A	lb.	.425 /	.455
40-P	lb.	.27 /	.30
50-B	lb.	.265 /	.295
80-P	lb.	.295 /	.325
DCHP	lb.	.59 /	.61
Ethox	lb.	.50 /	.525
Flexol 3GH	lb.	.44 /	.46
3G0	lb.	.53 /	.55
4G0	lb.	.325 /	.355
8N8	lb.	.355 /	.385
10-10, 810, CC-55, DOP	lb.	.305 /	.335
10-A, A-26	lb.	.425 /	.455
77-G, 426	lb.	.27 /	.30
B-400	lb.	.25 /	.28
R2H	lb.	.59 /	.595
T0F	lb.	.435 /	.475
Flexricin 66	lb.	.3275	
P-4		.30	
P-6	lb.	.37	
P-8	lb.	.32	
Good-rite GP-261	lb.	.305 /	.460
GP-233	lb.	.435 /	.585
Harflex 10	lb.	1.25 /	1.27
40	lb.	.64 /	.66
50	lb.	.58 /	.60
60	lb.	.62 /	.64
80	lb.	.61 /	.63
90	lb.	.88 /	.90
120, 150	lb.	.305 /	.335
140, 160	lb.	.30 /	.33
180	lb.	.295 /	.325
220	lb.	.425 /	.455
260	lb.	.42 /	.45
280	lb.	.43 /	.46
300	lb.	.63 /	.66
500	lb.	.315 /	.345
Butyl stearate	lb.	.23 /	.26
Sebacic acid, CP	lb.	.72 /	.76
Purified	lb.	.64 /	.68
Kapsol	lb.	.3225/	.3525
KP 23	lb.	.29 /	.32
-90	lb.		
-140	lb.	.46 /	.485
-201	lb.	.5825/	.5925
-220	lb.	.31 /	.34
-555	lb.	.45 /	.475
Kronisol	lb.	.33 /	.355
Kronitex AA, I, K-3, MX	lb.	.345 /	.375
Marvinol decylbutyl phthalate	lb.	.27 /	.30
Dibutyl phthalate	lb.	.30 /	.33
Sebacate	lb.	.665 /	.69
Diisooctyl adipate	lb.	.435 /	.465
Phthalate	lb.	.305 /	.335
Dinonyl adipate	lb.	.445 /	.475
Dioctyl adipate	lb.	.435 /	.465
Phthalate	lb.	.305 /	.365
Sebacate	lb.	.615 /	.64
Epoxy plasticizer	lb.	.345 /	.37
Isooctyl decyl phthalate	lb.	.305 /	.335
Tricresyl phosphate	lb.	.33 /	.36
Methox	lb.	.385 /	.41
Monsanto dibutyl phthalate	lb.	.30 /	.33
Diethyl phthalate	lb.	.25 /	.28
Dimethyl phthalate	lb.	.275 /	.305
Diphenyl phthalate	lb.	.5175/	.5375
DIDA, DOA	lb.	.425 /	.455
DIDP, DIOP, DOP	lb.	.305 /	.335
HB-20	lb.	.15 /	.17
HB-40	lb.	.22 /	.24
Orthonitrobiphenyl	lb.	.13 /	.15
Tricresyl phosphate	lb.	.33 /	.36
Triphenyl phosphate	lb.	.39 /	.40
Morflex P-50	lb.	.68 /	.71
Nuagatuck decylbutyl phthalate	lb.	.29 /	.30
Dibutyl phthalate	lb.	.30 /	.33
Sebacate	lb.	.645 /	.67
Diisooctyl adipate, dioctyl adipate	lb.	.425 /	.455
Diisooctyl phthalate, dioctyl phthalate, Isooctyl decyl phthalate	lb.	.305 /	.335
Dinonyl adipate	lb.	.445 /	.475
Dioctyl sebacate	lb.	.585 /	.61
Epoxy plasticizer	lb.	.335 /	.36
Tricresyl phosphate	lb.	.33 /	.36
Ohio-Apex butyl oleate	lb.	.2325/	.26
Stearate	lb.	.22 /	.25
Diallyl phthalate	lb.	.4975/	.5225
Dibutyl phthalate	lb.	.30 /	.33
Dicapryl phthalate	lb.	.295 /	.325
Di-Carbitol phthalate	lb.	.40 /	.425
Diisobutyl adipate	lb.	.4325/	.4625
Diisodecyl phthalate	lb.	.305 /	.335
Dioctyl phthalate	lb.	.305 /	.335
D.I.O.P.	lb.	.305 /	.335
Tributyl phosphate	lb.	.50 /	.53
Paraplex G-60, G-61	lb.	.3251/	.35
Pfizer acetyl tributyl citrate, tech	lb.	.32 /	.37
Acetyl triethyl citrate, tech	lb.	.36 /	.37
Triethyl citrate	lb.	.4575/	.58
Plasticizer 1	lb.	1.17 /	1.37
Plasticizer 120	lb.	.44 /	.49
Plastoflex 83	lb.	.52 /	.57
8520	lb.	.36 /	.435
D B E	lb.	.50 /	.55
MGB	lb.	.29 /	.37
VS	lb.	.38 /	.4575
Plastolein 9050 DHZ	lb.	.52 /	.56
9055 DGP	lb.	.28 /	.32
9057 DIOZ	lb.	.48 /	.52
9058 DOZ	lb.	.48 /	.52
9250 THFO	lb.	.3575/	.3975
9404 TGP	lb.	.38 /	.42
9715 & 9720 Polymeric	lb.	.37 /	.41
Polycizer 162, 562, 662	lb.	.305 /	.335
332, 532, 632	lb.	.425 /	.455
PX-104	lb.	.30 /	.33
-108, -118, -120, -138	lb.	.305 /	.335
-114	lb.	.27 /	.30
-208, -220, -238	lb.	.425 /	.455
-404	lb.	.645 /	.67
-438	lb.	.585 /	.61
-800	lb.	.325 /	.35
-917	lb.	.33 /	.36
Pycal 40	lb.	.3875/	.4375
60	lb.	.60 /	.635
62	lb.	.80 /	.835
94	lb.	.3275/	.3775
140	lb.	.35 /	.40
170	lb.	.275 /	.325
194	lb.	.2775/	.3275
Santicizer 1-H	lb.	.50 /	.51
3	lb.	.46 /	.47
8	lb.	.43 /	.44
9	lb.	.39 /	.42
140	lb.	.33 /	.36
141	lb.	.34 /	.37
160	lb.	.25 /	.28
601	lb.	.32	
602	lb.	.305	
B-16	lb.	.4875/	.4975
E-15	lb.	.5075/	.5375
M-17	lb.	.4275/	.4575
Staflex AX	lb.	.43	
BR	lb.	.26 /	.29
CP	lb.	.28 /	.31
DBES, DOS	lb.	.61 /	.635
DIOA, ODA	lb.	.435 /	.465
DIOP, DOP, MP	lb.	.305 /	.335
DOZ	lb.	.48 /	.5075
IXA	lb.	.32 /	.35
KA	lb.	.36 /	.3875
KD	lb.	.44 /	.4675
Witcizer #100	lb.	.26 /	.27
#101	lb.	.31 /	.32
#200	lb.	.195 /	.205
#201	lb.	.235 /	.245
#300	lb.	.30 /	.33
#312, 313	lb.	.305 /	.33
#412	lb.	.435 /	.465

Resins & Molding Compounds

Acrylic

Cadco cast rods	lb.	1.42 /	6.96
Polished	lb.	1.58 /	7.16
Machined rods	ft.	22.00 /	89.54
Tubes	lb.	1.39 /	5.76
Polished	lb.	1.51 /	5.99
Colors	lb.	1.62 /	5.99
Pearl	lb.	1.99 /	6.76
Lucite injection molding powders:			
Colorless, transparent	lb.	.68 /	.80
Std. colors	lb.	.72 /	1.00
Compression molding powders	lb.	.65 /	.75
Plexiglas molding powders:			
Colorless	lb.	.59 /	.80
Colors, stock	lb.	.63 /	.84
Custom	lb.	.63 /	1.00
Sheets, Types I-A & II			
Colorless	sq. ft.	.80 /	23.88
Colored	sq. ft.	.88 /	1.82
Type R: colorless	sq. ft.	.60 /	1.04
Colored	sq. ft.	.87 /	1.33
Polycast 1	sq. ft.	.80 /	2.40

Alkyd

Plaskon foundry resin 580-11L	lb.	.245 /	.275
Molding compound,			
Type 411	lb.	.43 /	.60
Type 413, 417	lb.	.57 /	.74
Type 420 black	lb.	.44 /	.695
Type 422 colored	lb.	.51 /	.695
Mottle	lb.	.52 /	.705
Natural	lb.	.49 /	.60
Type 430	lb.	.34 /	.50

Cellulosic

Cellulose acetate:			
Ampacet Group I	lb.	.80 /	.99
Group II	lb.	.46 /	.55
Group III			
Colors	lb.	.80 /	.89
Metallic	lb.	.63 /	.71
Pearl	lb.	.59 /	.68
Phosphorescent	lb.	.80 /	.89
Celanese film rolls			
Clear	lb.	.64 /	.87
Colors	lb.	.88 /	1.74
Sheets			
Clear	M. sq. in.	.032 /	.107
Colors	M. sq. in.	.042 /	.141
Lumarith molding cmpds.,			
Group I	lb.	.80 /	.99
Group II	lb.	.46 /	.55
Group III	lb.	.36 /	.45
Sheeting, extruded, non-stock			
Clear	lb.	.12 /	1.89
Colors	lb.	.15 /	2.07
Stock, clear	M. sq. in.	.12 /	1.62
Colors	M. sq. in.	.14 /	1.62
Cast, rolls			
Clear	M. sq. in.	.125 /	.558
Matte	M. sq. in.	.179 /	.648
Tinted	M. sq. in.	.239 /	.708
Sheets, clear	M. sq. in.	.141 /	1.52
Matte	M. sq. in.	.203 /	.788
Tinted	M. sq. in.	.255 /	1.72
Hercocel A, extrusion & injection	lb.	.50 /	.65
Injection, std colors	lb.	.46 /	.61
Special colors	lb.	.42 /	.45
Tenite Acetate, Group 1	lb.	.50 /	.59
Group 2	lb.	.46 /	.55
Group 3	lb.	.41 /	.51
Group 4	lb.	.38 /	.49
Group 5	lb.	.65 /	.75
Cellulose acetate butyrate:			
Tenite butyrate	lb.	.62 /	.71
A pearls	lb.	.72 /	.81
Blacks, reprocessed	lb.	.50 /	.58
Ethyl cellulose:			
Dyeform 720, 721	lb.	1.29 /	1.52
Ethocel P. G.	lb.	.72 /	.80
Bulk, reg.	lb.	.66 /	.81
Std., 7 cps.	lb.	.71 /	.86
Hercocel E	lb.	.72 /	.88

Epoxy

Araldite 502, 6010, 6020	lb.	.80 /	.995
504	lb.	.77 /	.965
551, 6060	lb.	.75 /	.95
6030, 6040	lb.	.885 /	.995
Bakelite ERL series	lb.	.80 /	.995
Epocast 2, 3, 5	lb.	1.33 /	1.77
4-B-2, 4-B, 4-C, 4-C-T, 4-D, Paste	lb.	1.15 /	1.55
Epon 828	lb.	.80 /	1.21
834	lb.	.90 /	1.56
864	lb.	.91 /	1.44
864-C-75	lb.	.73 /	.74
1001	lb.	.615 /	1.56
Furane CN-502	lb.	1.33 /	1.77
Jet-Kote (with cat.)	gal.	7.50 /	10.00
Rezolins A & B	lb.	1.29 /	1.74
Toolplastik packages:			
L-900, L-930	lb.	1.59 /	2.29
L-902	lb.	1.69 /	1.84
L-904	lb.	1.54 /	2.19
L-910	lb.	1.94 /	2.34
L-914	lb.	1.83 /	2.19
L-931	lb.	1.75 /	1.99
L-940	lb.	2.05 /	2.29

Fluorocarbon

Bakelite FGBB-33789, FGEB-34790, FXMA-50590, FXMB-50344	lb.	9.00 /	10.00
FGEB-32788, FXMB-50090	lb.	12.00 /	14.00
FVTD	lb.	11.00 /	13.00
FVTH, FVTS	lb.	8.50 /	9.50
Kel-F Grade 270, 300			
High density	lb.	9.00 /	10.00
Low density	lb.	8.50 /	9.50
Grade 300-P25	lb.	10.00 /	11.00
Polyfluoron, high density crystals & pellets	lb.	9.00 /	9.50
Colors	lb.	9.50 /	10.00
Low density powder	lb.	8.50 /	9.00
Dispersion grade	lb.	10.50 /	11.00
Teflon powder, dispersion	lb.	7.00 /	7.75
Fine	lb.	9.50 /	11.00
General	lb.	5.10 /	5.75
Tape cylinder	lb.	5.35 /	6.60

Melamine

Fiberite 2016	lb.	.95	
Melmac 402	lb.	.51 /	.53
404R, 404T	lb.	.85 /	.95
405	lb.	.45 /	.52
428	lb.	.48 /	.55
430	lb.	.465 /	.535
440	lb.	1.10	
480	lb.	.265 /	.315
1077, 1079	lb.	.47 /	.75
1500	lb.	.42 /	.55
1502	lb.	.45 /	.58
3020	lb.	.57 /	.72
3024-A	lb.	.67	
3135	lb.	.90 /	1.10
P-592, -592-A	lb.	.65 /	.75
Plaskon	lb.	.44 /	.75

Phenolic

91-LD	lb.	1.50 /	2.50
Admires PL-50	lb.	.215	
UP-11	lb.	.2325	
Bakelite general purpose	lb.	.187 /	.3525
BMG-5000	lb.	.19 /	.30
Colors	lb.	.2375/	.435
Chem. resist.	lb.	.23 /	.40
Electrical Insul.	lb.	.2725/	.4125
Heat resist.	lb.	.19 /	.35
Impact resist.	lb.	.24 /	.4025
Barrett foundry resins, liquid	lb.	.2125/	.2425
Powdered	lb.	.27 /	.355
Insulation resins	lb.	.15 /	.175
Molding resin 313, 314, 317	lb.	.27 /	.285
316	lb.	.295 /	.31
1502, -3, -4, -5, R-110R	lb.	.25 /	.265
R-114	lb.	.285 /	.30
Corfoam 107, 114	lb.	.55 /	.82
Cyacor 151	lb.	.215 /	.235
191	lb.	.13 /	.16
Durez, heat resist.	lb.	.19 /	.245
Impact resist.	lb.	.24 /	.63
Insulation	lb.	.21 /	.305
Non-Bleed	lb.	.19 /	.195
Special	lb.	.19 /	.665
Std.	lb.	.19 /	.245
Durite GP	lb.	.195 /	.24
HR	lb.	.191 /	.3025
IM	lb.	.24 /	.415
SG	lb.	.195 /	.3575
Dyform	lb.	1.10 /	1.35
Fiberite 1078	lb.	.42 /	.43
1087, 1165, 1270, 1271, 1330, 1332, 1347, FM 1132, FM 3510	lb.	.39 /	.395
1153	lb.	.455 /	.46
1167	lb.	.3875/	.3925
1340	lb.	.4275/	.4325
1346	lb.	.44 /	.4475
4010	lb.	.68	
4020	lb.	.815 /	.82
FM 926	lb.	.43 /	.435
927	lb.	.41 /	.415
1914	lb.	.375 /	.38
1957	lb.	.445 /	.45
1996	lb.	.375 /	.38
10365	lb.	.5225/	.5275
11547	lb.	1.05 /	1.06
11678	lb.	.52 /	.525
14111	lb.	.413 /	.42
17067	lb.	.851 /	.82
17610	lb.	1.05 /	1.06
G-E 12368, 12374, 12392 shell molding resins	lb.	.26 /	.35
12401	lb.	.2975	
12408, 12460, 12486, 12490, 12491, 12493, 12853, 12875, 12883, 12885, 12886, 12900, 12901	lb.	.195 /	.20
12410, 12420	lb.	1.50	
12432	lb.	.395	
12433	lb.	.555	
12435	lb.	.24	
12439, 12466	lb.	.265	
12444	lb.	.425	
12462	lb.	.505	
12463	lb.	.405	
12467	lb.	.51	
12487, 12489, 12884, 12887	lb.	.355	
12494	lb.	.375	
12495	lb.	.245	
12808	lb.	.49	
12809	lb.	.65	
12817, 12882	lb.	.205 /	.21
12841	lb.	.2425	
Loven LHR-401, -403	lb.	.225 /	.23
-407, -409	lb.	.60 /	1.00
-408	lb.	.25 /	.255
LI201	lb.	.39 /	.40
-207	lb.	.475 /	.48
-209	lb.	.60 /	1.00
-212	lb.	.425 /	.43
LM-110, -119	lb.	.19 /	.195
-101	lb.	.24 /	.245
-116	lb.	.255 /	.26
-117	lb.	.225 /	.23
-118	lb.	.1975/	.2025
LMI-301	lb.	.2525/	.2575
-303	lb.	.345 /	.35
-304	lb.	.60 /	1.00
-307	lb.	.3075/	.3125
LMM-801, -803	lb.	.2125/	.2175
-804, -811	lb.	.245 /	.25
-807	lb.	.215 /	.22
Marblette casting resins	lb.	.50 /	.60
Plenco foundry resins	lb.	.27 /	.35
Molding cmpds., gen. purpose	lb.	.185 /	.233
Heat resist.	lb.	.19 /	.24
Improved impact	lb.	.225 /	.28
Min. bleed	lb.	.185 /	.195
Radio & TV	lb.	.20 /	.215
Stock	lb.	.205 /	.34
R-72S casting resin	lb.	.46 /	.74
Reilly general purpose	lb.	.195 /	.20
Heat & impact resist.	lb.	.20 /	.205
Resinox, gen. purpose, heat resist.	lb.	.19 /	.20
Impact	lb.	.245 /	.3125
Low elec. loss	lb.	.30 /	.355
Special	lb.	.20 /	.24
Rogers RX-425	lb.	.285 /	.35
-428	lb.	.345 /	.42
-429	lb.	.355 /	.425
-431	lb.	.4125/	.495
-438	lb.	.4575/	.4625
-442	lb.	.3375/	.3425
-447	lb.	.495 /	.50
-448	lb.	.345 /	.35
-458	lb.	.37 /	.375
-469	lb.	.355 /	.36
-525	lb.	.285 /	.29
-530	lb.	.4125/	.4175
-625	lb.	.385 /	.39
Schenectady shell mold resins	lb.	.26 /	.28
Toolplastik No. 8000	lb.	.48 /	.72

Polyamide

G.M.I. Polyamide 115	lb.	.64 /	.77
Versamid 115	lb.	.64 /	.82
Zytel molding powder	lb.	1.435 /	1.60

Polyester

Atlac 363E-02Z, -12Z	lb.	.66 /	.69
-32Z	lb.	.68 /	.71
382E	lb.	.57 /	.60
FP	lb.	.66 /	.69
Bakelite Polyester resins	lb.	.35 /	.75
Diall 50-01, 50-51, 50-52	lb.	2.75 /	3.50
51-01	lb.	.87 /	.98
52-01	lb.	1.95 /	2.50
52-20-30	lb.	1.30 /	1.50
Fibercore 1000, 2000	lb.	.50 /	.65
3000	lb.	.55 /	.70
G-E polyesters:			
AR 401	lb.	.35 /	.365
AR 403, 480	lb.	.34 /	.355
AR 403 LS, 480 LS	lb.	.355 /	.37
AR 493	lb.	.40 /	.415
AR 499	lb.	.435 /	.45
AR 501	lb.	.455 /	.47
Hetron	lb.	.43 /	.485
IC-312, -400, -514, -548, -625, -730, -800	lb.	.35 /	.385
-312-2	lb.	.365 /	.38
-336, -382, -706	lb.	.37 /	.385
-401	lb.	.44 /	.455
-420	lb.	.355 /	.37
-433	lb.	.38 /	.395
-636, -670	lb.	.48 /	.495
-638, -689	lb.	.55 /	.565
-670-2	lb.	.50 /	.515
-671	lb.	.405 /	.42
Filled resins	lb.	.255 /	.54
Laminac 4110	lb.	.33 /	.345
4111	lb.	.45 /	.465
4116	lb.	.33 /	.345
4120	lb.	.39 /	.405
4123, 4128	lb.	.34 /	.355
4134	lb.	.46 /	.475
4146	lb.	.43 /	.445
4192	lb.	.355 /	.37
4202	lb.	.55 /	.565
Mylar, rolls, types A & C	lb.	2.50 /	4.80
Type D	lb.	3.00 /	3.30
Sheets, type A	M. sq. in.	.09 /	1.11
Type C	M. sq. in.	.09 /	.15
Type D	M. sq. in.	.53 /	1.34
Plaskon 911, 920	lb.	.55 /	.665
941, 942, 951, 9411	lb.	.35 /	.465
943	lb.	.41 /	.525
9404	lb.	.365 /	.48
9406	lb.	.355 /	.465
9500, 9510, 9511	lb.	.35 /	.465
9600	lb.	.44 /	.555
Polycast 2	sq. ft.	1.89 /	5.18
3	sq. ft.	1.08 /	18.00
6	sq. ft.	.66 /	3.10
7	sq. ft.	.72 /	7.18
CR-39	sq. ft.	1.25 /	20.00
Pre-Imp	lb.	.68 /	.85
Thermaflow 100T	lb.	.62 /	1.05
120	lb.	.89 /	1.25
200T, 300T	lb.	.62 /	1.05
400T, 500T	lb.	.70 /	1.10
Vibrin No. 112	lb.	.40 /	.515
114, 117, 118, 151, 152	lb.	.35 /	.465
115A	lb.	.38 /	.495
121	lb.	.46 /	.575
135	lb.	3.00	
142	lb.	.55 /	.665
152	lb.	.365 /	.48
X-1029	lb.	.35 /	.465
X-1055B	lb.	.62 /	.73
X-1633A	lb.	.49 /	.605
X-1636W	lb.	.585 /	.70

Polyethylene

A-C No. 6, 617	lb.	.30 /	.37
No. 6A, 7, 617A	lb.	.35 /	.42
No. 615, G-201	lb.	.38 /	.45
No. 629	lb.	.40 /	.47
No. 729	lb.	.45 /	.52
Alathon	lb.	.41 /	.505
Bakelite DE Series	lb.	.43 /	.725
DYGT	lb.	.54 /	.69
DYLT, DYNF, DYNH	lb.	.41 /	.59
DYNJ	lb.	.44 /	.62
DYNK	lb.	.45 /	.63
Catalin 15-5	lb.	.41 /	.59
Celanese film, rolls	lb.	.61	
Sheets	M. sq. in.	.033 /	.237
Sheeting, rolls	lb.	.85 /	.98
Sheets	lb.	.98 /	1.15
Petrothene 100	lb.	.43 /	.47
200	lb.	.41 /	.45
Poly-Eth 1003	lb.	.44 /	.58
1004, 1005, 1007, 1008.5	lb.	.41 /	.55
3015, 5015	lb.	.35 /	.49
Reynolon 1000, P series	lb.	.60 /	.80
Tenite Group 1	lb.	.41 /	.45
Group 2	lb.	.43 /	.47
Group 3	lb.	.46 /	.50
Group 4	lb.	.39 /	.43
Group 5, 6	lb.	.50 /	.72
Group 7	lb.	.60 /	.82
Group 8	lb.	.70 /	.92

Silicone

Bakelite GMGA-5001, -5002	lb.	2.75 /	3.10
5003	lb.	4.00 /	4.35
5004	lb.	5.40 /	5.75

Styrenes

Ampacet, crystal	lb.	.315 /	.335
Colors, std.	lb.	.345 /	.365
Special	lb.	.345 /	.75
Pearl	lb.	.41 /	.75
Phosphorescent	lb.	.695 /	1.00
Tinsel	lb.	.41 /	.67
Confetti	lb.	.51 /	.70
Bakelite BMC series, nat.	lb.	.45 /	.685
Colors	lb.	.50 /	.735
BMS, SMD series, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	.52
RMD series, nat.	lb.	.45 /	.685
Colors	lb.	.50 /	.735
TGD series	lb.	.33 /	.35
Colors, std.	lb.	.36 /	.38
Special	lb.	.36 /	1.00
TMD series	lb.	.33 /	.40
Colors, std.	lb.	.36 /	.43
Special	lb.	.36 /	1.00
Catalin, high impact, natural	lb.	.325 /	.355
Colors, std.	lb.	.355 /	.385
Special	lb.	.36 /	1.00
Medium impact, natural	lb.	.325 /	.355
Colors, std.	lb.	.355 /	.385
Special	lb.	.355 /	1.00
Regular grade, crystal	lb.	.305 /	.325
Colors, std.	lb.	.345 /	.365
Special	lb.	.345 /	1.30
Utility black	lb.	.18 /	.235
Cycolac 12769 A, 12877, 12968, 12982	lb.	.73 /	.81
12803	lb.	.65 /	.73
12830, 12967	lb.	.70 /	.78
12876 A	lb.	.69 /	.77
12981	lb.	.78 /	.86
12983	lb.	.76 /	.84
12984	lb.	.77 /	.85
13022	lb.	.72 /	.80
Natural Powder	lb.	.58 /	.66
Pellets nat. & std. colors	lb.	.65 /	.73
Darex Copolymer 3	lb.	.47 /	.67
43G, X34	lb.	.42 /	.61
Latices 3L, 34L, 616L	lb.	.335 /	.48
610L	lb.	.30 /	.46
Dow Latex, polystyrene	lb.	.30 /	.46
Latices, styrene/butadiene	lb.	.30 /	.46
Dylite, expandable beads	lb.	.50 /	.60
Koppers, Fibertuff	lb.	.55 /	1.505
MC-185 series	lb.	.33 /	.355
-300 series	lb.	.33 /	1.005
-400 series	lb.	.355 /	1.005
Regular, crystal	lb.	.295 /	.315
Colors, std.	lb.	.335 /	.355
Special	lb.	.335 /	1.005
Pearl	lb.	.41 /	1.005
Phosphorescent	lb.	.695 /	2.005
Kralastic, std. colors	lb.	.50 /	1.10
Lustrex Hi-Flow 53, crystals	lb.	.295 /	.31
Hi-Test 88, std.	lb.	.36 /	.38
Special colors	lb.	.36 /	1.00
L, crystals	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
LHA, std.	lb.	.355 /	.375
Special	lb.	.355 /	1.00
Utility black, gen. purpose	lb.	.18 /	.185
High impact	lb.	.235 /	.24
Medium impact	lb.	.19 /	.195
Marbon resins	lb.	.39 /	.46

Plio-Tuf C75	lb.	.37 /	.40
G85	lb.	.52 /	.54
Plio-Tuf G75C, G85C	lb.	.52 /	.55
Polycast 4	sq. ft.	2.56 /	11.07
Styron 475, natural	lb.	.33 /	.35
Colors, std.	lb.	.36 /	.38
Special	lb.	.36 /	1.00
Sheets, std.	lb.	.55 /	.60
Special	lb.	.55 /	.62
480, natural, black	lb.	.38 /	.40
Colors, std.	lb.	.41 /	.43
Special	lb.	.41 /	1.00
647, crystal	lb.	.305 /	.32
Colors, special	lb.	.345 /	1.34
666, 688, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
700, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
777 colors, std.	lb.	.355 /	.375
Special	lb.	.355 /	1.00

Urea

Admirez SP-30	lb.	.27	
UP-50	lb.	.105	
Beetle C-4980, T-298	lb.	.1875/	.30
MUP series, powder	lb.	.30 /	.49
Special colors	lb.	.30 /	.59
Granules	lb.	.33 /	.52
Special colors	lb.	.33 /	.62
Plaskon molding cmpds.:			
Colors, single	lb.	.1875/	.30
Special	lb.	.30 /	.62
Standard	lb.	.30 /	.52
Foundry resins, liquid	lb.	.10 /	.13
Powdered	lb.	.2325/	.2525

Vinyls

Bakelite QG-5909	lb.	.35 /	.585
QG-5921	lb.	.41 /	.645
5924	lb.	.43 /	.665
QYNA, QYSM, QYSQ	lb.	.27 /	.47
QYNV	lb.	.30 /	.50
QYSJ	lb.	.28 /	.48
VG-1914, 1918	lb.	.37 /	.605
1985	lb.	.35 /	.585
5507	lb.	.31 /	.545
5544	lb.	.405 /	.64
5911	lb.	.315 /	.55
5980	lb.	.32 /	.555
7734	lb.	.28 /	.515
9031	lb.	.265 /	.50
9530	lb.	.275 /	.51
9960, 9970, 9980	lb.	.335 /	.57
VAGH	lb.	.55 /	.75
VMCH	lb.	.41 /	.61
VYDR, VYNW	lb.	.27 /	.47
VYHH	lb.	.32 /	.52
VYLF	lb.	.36 /	.56
VYNS	lb.	.44 /	.64
VYNV	lb.	.32 /	.52
Blacar No. BW-60	lb.	.315 /	.385
NEMA colors	lb.	.355 /	.425
No. BW-80	lb.	.405 /	.455
NEMA colors	lb.	.445 /	.495
No. PC white, ivory, black	lb.	.285 /	.335
Other colors	lb.	.325 /	.375
Darex Everplex A (wet wt.)	lb.	.21 /	.39
B (wet wt.)	lb.	.22 /	.40
G (wet wt.)	lb.	.21 /	.39
Copolymer Y (wet wt.)	lb.	.245 /	.28
PVA Emulsions (wet wt.)	lb.	.19 /	.355
Diamond PVC-45, -50	lb.	.38 /	.44
Dow PVC-100, -111	lb.	.38 /	.57
Exon 402A, 500, 905, 915, 925	lb.	.31 /	.51
450, 468R, 480	lb.	.35 /	.55
461	lb.	9.75	
468	lb.	.33 /	.53
470	lb.	.55	
471	lb.	.50	
654	lb.	.34 /	.54
Formvar	lb.	.865 /	1.03
Geiva emulsions	lb.	.19 /	.205
Granules	lb.	.4175/	.6175
Geon 101, 101EP, 103EP, 202	lb.	.31 /	.49
121	lb.	.34 /	.52
126	lb.	.32 /	.50
200X20	lb.	.37 /	.55
205, 400X65, 400X74L, 400X78	lb.	.35 /	.53
400X80	lb.	.45 /	.63
400X110	lb.	.42 /	.60
404HI	lb.	.40 /	.58
2042, 2046	lb.	.335 /	.57
2042, colors	lb.	.385 /	.62
6373, 8372	lb.	.365 /	.60
Colors	lb.	.415 /	.65
6461	lb.	.345 /	.58
Colors	lb.	.395 /	.63
8539	lb.	.35 /	.585
Colors	lb.	.37 /	.605
8600, 8620	lb.	.295 /	.53
Colors	lb.	.345 /	.58
8630	lb.	.445 /	.68
Colors	lb.	.495 /	.73
8640	lb.	.37 /	.605
8650	lb.	.33 /	.565
8656	lb.	.38 /	.615
8677	lb.	.455 /	.69
8700A, 8750	lb.	.455 /	.69
Colors	lb.	.485 /	.72
8720	lb.	.625 /	.86
8726, 8737	lb.	.35 /	.585
8740	lb.	.315 /	.55
8749	lb.	.31 /	.545
8800	lb.	.55 /	.785
8801	lb.	.295 /	.53
Colors	lb.	.345 /	.58
8802	lb.	.35 /	.585
Colors	lb.	.40 /	.635
8804	lb.	.30 /	.535
8807	lb.	.45 /	.685
8809	lb.	.39 /	.625
8812, 8813, 8814, 8815	lb.	.345 /	.58
Latex 151, 251	lb.	.29 /	.75
351	lb.	.34 /	.75
352	lb.	.31 /	.75
552	lb.	.39 /	.75
576	lb.	.36 /	.75
652	lb.	.37 /	.75
Polyblend	lb.	.445 /	.545
Goodrich PVC Plastisols (dry wt.)	lb.	.38 /	.72
Krene, film	lb.	.505 /	.655
Sheeting	lb.	.49 /	.645
Marvinols, NF series	lb.	.285 /	.705
NR series	lb.	.41 /	.765
Opalon 300, 300FM	lb.	.31 /	.51
410	lb.	.34 /	.54
505	lb.	.35 /	.55
Inj. molding cmpds.	lb.	.29 /	.67
Profile extrusion cmpds.	lb.	.29 /	.72
Wire cmpds.	lb.	.29 /	.67
Plastiflex, std.	lb.	.90 /	1.10
Novelty	lb.	1.15 /	1.50
Pliovic AO (dispersion)	lb.	.34 /	.36
DB80V, DB90V, EDB90V	lb.	.31 /	.33
Latex 300	lb.	.30 /	.45
Reynolon, 4000 series	lb.	1.55 /	2.30
Rolls, 1-mil	sq. yd.	.0625/	.11
Colors	sq. yd.	.0675/	.08
4-mil	sq. yd.	.215 /	.3125
Colors	sq. yd.	.2375/	.255
16-mil	sq. yd.	.81 /	1.19
Colors	sq. yd.	.86 /	.945
Satinflex	lb.	1.15 /	1.50

Vinylidine

Dow Latex 744-B	lb.	.30 /	.46
Saran formulation 115, black, nat.	lb.	.39 /	.52
Colors	lb.	.44 /	.69
720 nat.	lb.	.41 /	.54
Colors	lb.	.46 /	.71
747 nat.	lb.	.395 /	.525
761 nat.	lb.	.39 /	.52
Colors	lb.	.44 /	.69
820 nat.	lb.	.42 /	.55
Colors	lb.	.47 /	.60
Latices	lb.	.45 /	.61
Resin F 120	lb.	.58 /	.65

Solvents

Enjay acetone	gal.	.07 /	.10
Isopropyl acetate	gal.	.105 /	.135
Methyl ethyl ketone	gal.	.115 /	.145
Secondary butyl acetate	gal.	.1125/	.1425
Butyl alcohol	gal.	.115 /	.145
Petrohol 91%	gal.	.37 /	.57
95%	gal.	.39 /	.59
99%	gal.	.41 /	.61

Stabilizers

Advastab 3, 52, OM-10	lb.	1.90 /	1.95
17-M	lb.	2.95 /	3.00
21	lb.	1.00 /	1.05
48-79, C-77	lb.	.85 /	.90
50-LT, T-72	lb.	3.20 /	3.25
89-X	lb.	.70 /	.75
BA-13-P, BC-105	lb.	.75 /	.80
BC-12	lb.	.90 /	.95
CH-20, E-49	lb.	.55 /	.60
E-98	lb.	.53 /	.58
JCX	lb.	.62 /	.67
L paste	lb.	.65 /	.70
OM-18	lb.	3.10 /	3.15
SN	lb.	.47 /	.52
X23-30	lb.	.75 /	.80
Barca 10	lb.	.75 /	.80
Baker barium ricinoleate	lb.	.70	
Calcium ricinoleate	lb.	.55	
Zinc ricinoleate	lb.	.60	
Dutch Boy Barinac	lb.	.70	
Calstar	lb.	.36	
CS-137	lb.	1.25	
DS-207	lb.	.54 /	.555
Dyphos	lb.	.57 /	.585
50A	lb.	.335	
Dythal	lb.	.395 /	.41
L-26	lb.	.50	
Leadstar	lb.	.39	
Normal lead maleate	lb.	.4475	
Normasal	lb.	.46	
Pearlescent pigment	lb.	1.00	
Plumb-O-Sil-A	lb.	.2975	
-B	lb.	.3125/	.36
-C	lb.	.3425/	.375
Tribase	lb.	.265 /	.28
-E	lb.	.215	
Trimal	lb.	.435	
Harshaw 1-V-3	lb.	.43	
1-V-4	lb.	.68	
1-V-7	lb.	.66 /	.71
2-V-4	lb.	.85 /	.90
2-V-7	lb.	1.10 /	1.15
2-V-8	lb.	1.30	
2-V-400	lb.	.80 /	.85
5-V-1	lb.	.41	
5-V-22	lb.	.49	
7-V-1	lb.	.90 /	.95
7-V-2	lb.	.95 /	1.00
7-V-4	lb.	1.18 /	1.23
8-V-1	lb.	1.10 /	1.15
8-V-5	lb.	.80 /	.85
8-V-100	lb.	.84 /	.89
9-V-1	lb.	.76 /	.81
12-V-5	lb.	.75	
22-V-1	lb.	1.28	
24-V-1	lb.	1.28 /	1.33
28-V-2	lb.	1.18	
128-V-5	lb.	.86	
281-V-4	lb.	.90	
Merix AST Concentrate 1001	lb.	.355 /	1.75
Metasap 613-A	lb.	.69	
613-B	lb.	.84	
613-C	lb.	1.06	
621	lb.	.88	
624	lb.	.75	
Cadmium stearate	lb.	1.40 /	1.44
Fused stearates, calcium 602-A	lb.	.25 /	.30
Dibasic lead stearate	lb.	.56	
Lead 611	lb.	.32 /	.37
Lead stearate	lb.	.39 /	.44
Nuostable V-1	lb.	.54 /	.59
V-2	lb.	.39 /	.44
V-10	lb.	.70 /	.75
V-20	lb.	1.30 /	1.35
V-21	lb.	1.29 /	1.34
V-30	lb.	.90 /	.95
V-31	lb.	.80 /	.85
V-40	lb.	1.18 /	1.23
V-42	lb.	.65 /	.70
V-43	lb.	.75 /	.80
V-44	lb.	.90 /	.95
V-45	lb.	1.10 /	1.15
V-50	lb.	.49 /	.54
V-60	lb.	.37 /	.42
V-70	lb.	.68 /	.73
V-80	lb.	2.80 /	2.85
V-81	lb.	2.90 /	2.95
Stabelan E	lb.	1.35 /	1.50
HR, liquid	lb.	.65 /	.75
Paste	lb.	.85 /	.95
Powder	lb.	.95 /	1.05
HR-50	lb.	.75 /	.90
XL	lb.	.55 /	.65
Stabilizer #3, 52	lb.	1.90 /	2.00
17-M	lb.	3.00 /	3.25
#42	lb.	.83 /	.93
89-X	lb.	.75 /	.80
#143	lb.	.80 /	.90
A-S	lb.	1.25	
BC-12	lb.	.87 /	.95
BC-105	lb.	.75 /	.85
C-2	lb.	1.65	
C-77	lb.	.85 /	.95
CH-14	lb.	.63 /	.70
CH-20	lb.	.63 /	.65
D-22	lb.	1.99 /	2.05
E-6-B	lb.	.80 /	.90
E-49	lb.	.60 /	.65
E-98	lb.	.55 /	.65
JCX	lb.	.62 /	.68
L-Paste	lb.	.60 /	.65
Mark E	lb.	.72 /	.85
M	lb.	.73 /	.83
PL	lb.	.74 /	.84
TT	lb.	.77 /	.91
V	lb.	.91 /	1.04
X	lb.	2.50 /	2.75
XI	lb.	.87 /	1.01
XV	lb.	.92 /	1.01
XX	lb.	.63 /	.74
OM-10	lb.	1.90 /	2.00
-18	lb.	3.10 /	3.35
P-1835	lb.	3.20 /	3.35
PS-38	lb.	.50 /	.65
SN	lb.	.47 /	.53
T-72	lb.	3.20 /	3.35
V-I-N	lb.	.40 /	.48
VL-3	lb.	.95 /	1.05
Stafiex QMXA	lb.	.70	
50% in DOP	lb.	.52	
OY	lb.	1.60 /	1.20
Stayrite #10	lb.	.33 /	.37
#15	lb.	.54 /	.57
#20	lb.	.38 /	.42
#22	lb.	1.32 /	1.34
#25	lb.	.36 /	.40
#70, 75, 80, 90	lb.	.69 /	.70
#229	lb.	.47 /	.50
P-10	lb.	.40 /	.44
Thermolite 12	lb.	2.00 /	2.25
13	lb.	3.10 /	3.78
15	lb.	4.13	
17	lb.	2.45 /	2.75
20	lb.	2.95 /	3.25
39	lb.	2.75 /	3.25
91	lb.	3.00	
Vanstay C, S	lb.	.63 /	.65
HT	lb.	.90 /	.92
L	lb.	.33 /	.35
R	lb.	.70 /	.72

Wetting Agents

Advawet X-212	lb.	.50 /	.55
Poly-Iube No. 4	gl.	1.45 /	1.94